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AMERICAN SOCIETY
FOR
TESTING MATERIALS.

AFFILIATED WITH THE
INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.

PROCEEDINGS

OF THE

FIFTEENTH ANNUAL MEETING

Held at New York, N. Y.,
March 28–29, 1912.

VOLUME XII.

EDITED BY THE SECRETARY,
UNDER THE DIRECTION OF THE COMMITTEE ON PUBLICATIONS.

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PREFATORY NOTE.

The Fifteenth Annual Meeting of the Society was held in March instead of June, and was restricted to the presentation of Committee reports and to administrative business, with the view of not detracting from the interest in the impending Sixth Congress of the International Association for Testing Materials to be convened in New York early in September of the same year. By reason of these exceptional circumstances the proceedings are not issued this year in the usual form of a separate volume, but appear here under the same cover with the Year-book.—Ed.

47,967

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SUMMARY OF THE PROCEEDINGS OF THE FIFTEENTH ANNUAL MEETING.

New York City, March 28 and 29, 1912.

The Fifteenth Annual Meeting of the American Society for Testing Materials was held at the Hotel Astor, New York City, on March 28–29, 1912. The total registered attendance at the meeting was 231.

The following members were present or represented at the meeting:

Adams, H. H.
Addicks, Lawrence.
Aertsen, Guilliaem.
Aiken, W. A.
Ajax Metal Company, G. H. Clamer.
Aken, T. R.
Allen, I. C.
American Asphaltum and Rubber Company, H. B. Pullar.
American Brass Company, W. H. Bassett.
American Electric Railway Engineering Association, Norman Litchfield.
American Foundrymen's Association, Richard Moldenke.
American Locomotive Company, F. J. Cole.
American Steel and Wire Company, S. M. Rodgers.
Armstrong, T. P.

Babcock, W. S.
Backert, A. O.
Baldwin Locomotive Works, A. B. Johnson, Jr.
Barnes, H. C.
Barrett Manufacturing Company, W. S. Babcock.
Barrier, E. A.
Bates, P. H.
Baxter, F. R.
Beale, H. A., Jr.
Belden, A. W.
Berry, H. C.
Blair, W. P.
Blanchard, A. H.
Blauvelt, W. H.
Bole, W. A.
Boston Elevated Railway Company, J. W. Allen.
Bostwick, W. A.
Boughton, E. W.
Bowman, A. L.
Boyer, E. D.
Boynton, C. W.
Boynton, H. C.
Braine, L. F.
Buffalo, Rochester and Pittsburg Railway Company, H. G. Burnham.
Bureau of Construction and Repair, U. S. N., J. O. Gawne.

Bureau of Steam Engineering,
U. S. N.,
C. A. Carr.
J. F. Daniels.
Gustav Karmmerling.
Burrows, C. W.

Calumet Steel Company,
A. S. Hook.
Campbell, William.
Capp, J. A.
Carnegie Steel Company,
C. F. W. Rys.
Carney, F. D.
Carpenter, A. W.
Carpenter, R. C.
Carpenter Steel Company,
J. H. Parker.
Chamberlain, G. D,
Chase, W. D.
Church, S. R.
Cobb, E. B.
Colby, A. L.
Condit, E. A., Jr.
Conradson, P. H.
Corse, W. M.
Corthell, E. L.
Cushman, A. S.

Davis, N. H.
Derby, W. A.
de Wyrall, Cyril.
Douty, D. E.

Electrical Testing Laboratories,
F. M. Farmer.
Engineering Record,
J. M. Goodell.
Evans, R. W.
Evans, S. M.
Ewing, W. W.

Fackenthal, B. F., Jr.
Falkenau, Arthur.
Farmer, F. M.
Ferguson, L. R.
Force, H. J.
Fort, E. J.
Foss, F. E.
Fowler, G. L.
Franklin Steel Company,
E. E. Hughes.

Gannon, T. J.
Gardner, E. S.
General Electric Company,
J. A. Capp.
Gibboney, J. H.
Gibbs, A. W.
Gill, A. H.
Glasgow Iron Company,
J. P. Roe.
Goodspeed, G. M.
Gormully, A. R.
Gulich, Henry, Jr.

Hall, E. B.
Hammond, G. T.
Heath, F. C.
Hering, Rudolph.
Herron, J. H.
Hibbard, H. D.
Holst, J. L.
Howe, H. M.
Howell, S. A.
Hubbard, Prévost.
Humphrey, Richard L.
Hunnings, S. V.

Illinois Steel Company,
C. G. Osborne.
Interstate Iron and Steel Company,
S. J. Llewellyn.
Iron Age, The,
W. W. Macon.

Jefferson, H. F.
Job, Robert.
Jones and Laughlin Steel Company,
J. J. Shuman.
F. S. Slocum.

Keeler, W. I.

Kinkead, J. A.
Kinney, W. M.
Koch, G. B.

Lackawanna Steel Company,
F. E. Abbott.
Lane, F. A.
Langenbach, E. A.
J. D. Higgins.
Lanza, Gaetano.
Lawrie, J. W.
Lawson, T. R.
Leech, J. O.
Lesley, R. W.
Lowe Brothers Company, The,
Anderson Polk.
Lucas and Company, John,
L. P. Nemzek.
Lynch, T. D.

MacFarland, H. B.
MacGregor, J. R.
Macgregor, J. S.
Mahon, R. W.
Marburg, Edgar.
Marsh, C. P.
McBurney, Henry.
McDonnell, M. E.
McFarland, G. S.
Meade, R. K.
Merriman, Mansfield.
Metal Industry, The,
L. J. Krom.
Midvale Steel Company,
Radclyffe Furness.
Miller, R. P.
Moisseiff, L. S.
Moldenke, Richard.
Molleson, G. E.
Morrow, J. G.
Mory, A. V. H.
Moyer, Albert.
Myer, C. R.

National Tube Company,
F. N. Speller.
New Jersey Zinc Company,
Gilbert Rigg.
New York Central and Hudson River
Railroad Company,
A. W. Carpenter.
Norris, G. L.
Nuessey, W. H.

Ogden, Benjamin.
Olsen, T. Y.
Orford Copper Company,
J. F. Thompson.
Orton, Edward, Jr.
Osborne, C. G.
Owen, James.

Page, L. W.
Penn Steel Castings and Machine
Company, R. B. Farquhar, Jr.
Pennsylvania Steel Company,
F. A. Robbins, Jr.
Perry, R. S.
Pew, J. H.
Pichard, G. H.
Polk, Anderson.
Porter, J. M.
Provost, A. J., Jr.

Ray, D. H.
Reeve, C. S.
Remington Arms and Ammunition
Company, R. D. Cady.
Reninger, H. A.
Richards, J. W.
Rigg, Gilbert.
Rights, L. D.
Rodgers, S. M.
Rogers, R. E.
Rome Merchant Iron Mill,
Weston Jenkins, Jr.
Rys, C. F. W.

Sabin, A. H.
Sauveur, Albert.
Sawyer, A. H.

Schaeffer, J. A.
Schmitt, F. E.
Schwartz, A. W.
Seabury, R. W.
Sharples, P. P.
Sherrerd, J. M.
Shore, A. F.
Shuman, J. J.
Skinner, C. E.
Skinner, O. C.
Slocum, F. S.
Smith, H. E.
Spackman Engineering Company,
Henry S., H. S. Spackman.
Spare, C. R.
Stafford, B. E. D.
Stafford, S. G.
Standard Steel Works Company,
O. C. Skinner.
A. A. Stevenson.
H. F. Walker.
Stevenson, A. A.
Stratton, S. W.
Stütz, Earnest.

Taber, G. H.
Thacher, S. P.
Thompson, G. W.
Thompson, J. F.
Thorpe, J. B.
Tilt, E. B.
Tretch, W. J.
Trist, N. B.

Voorhees, S. S.

Wadleigh, F. R.
Waldo, Leonard.
Walker, H. F.
Wallace, J. T.,
L. G. Blackmer.
Walter, L. W.
Webster, W. R.
Western Electric Company,
C. R. Myer.
Westinghouse, Church, Kerr and Company,
C. M. Chapman.
Westinghouse Electric and Manufacturing Company,
T. D. Lynch.
C. E. Skinner.
Whipple, G. C.
Wiese, H. B.
Wight, F. C.
Wilson, P. H.
Woodroffe, G. H.
Wyman and Gordon Company, The,
G. S. McFarland.

Young, C. D.
Young, J. B.
Youngstown Sheet and Tube Company, E. T. McCleary.

FIRST SESSION.—THURSDAY, MARCH 28, 10 A. M.

President Henry M. Howe in the chair.

The minutes of the Fourteenth Annual Meeting were approved as printed.

The annual report of the Executive Committee was adopted as printed.

The Chairman then read the annual presidential address.

Mr. Charles W. Burrows, Chairman of Committee A-6 on the Magnetic Testing of Iron and Steel, presented the report

of that Committee including the proposed amendments to the Standard Magnetic Tests of Iron and Steel.

On motion, these amendments were referred to letter ballot of the Society.

The report of Committee E-5 on Rules Governing the Form but not the Substance of Specifications, was presented by Mr. Edgar Marburg, Chairman.

Mr. J. A. Capp, Chairman of Committee B-1 on Standard Specifications for Copper Wire, presented the report of that Committee embodying proposed Standard Specifications for Medium Hard drawn Copper Wire and for Soft or Annealed Copper Wire.

Mr. Capp moved that these two proposed standard specifications be referred to letter ballot of the Society, with the understanding that the numerical values for resistivity will be subject to modification when an agreement on an international standard has been reached by the International Electrotechnical Commission, and that Committee B-1 on Standard Specifications for Copper Wire, and Committee B-2 on Non-Ferrous Metals and Alloys, will cooperate with a view of bringing about such an agreement. This motion was carried.

Mr. William Campbell, Chairman of Committee B-2 on Non-Ferrous Metals and Alloys, reported progress in the work of that Committee.

The following amendments of the by-laws, proposed in the Annual Report of the Executive Committee, were on motion approved and referred to letter ballot of the Society:

ARTICLE I. MEMBERS.

Strike out:

SECTION 1. The Society shall consist of Members and Junior Members.

Substitute:

SECTION 1. The Society shall consist of Junior Members, Members and Honorary Members.

Add the following new section:

SEC. 4. An Honorary Member shall be a person of widely recognized eminence in some part of the field which the Society aims to cover as defined in Paragraph 2 of the Charter. The number of Honorary Members

shall not exceed ten. A nominee for honorary membership shall be proposed by at least ten members and shall be elected only by unanimous vote of the Executive Committee.

Number the present Section 4, Section 5.

ARTICLE II. OFFICERS AND THEIR ELECTION.

Strike out:

SECTION 1. The officers shall be a President, Vice-President, Secretary and Treasurer.

SEC. 2. The offices of Secretary and Treasurer shall be held by the same person.

SEC. 3. These officers shall be elected by letter ballot, at the Annual Meeting, and shall hold office for two years.

SEC. 4. The Executive Committee shall consist of these officers and also the last Past President and seven members, four being elected by letter ballot at each Annual Meeting in the odd years and three at each Annual Meeting in the even years. Four members of the Executive Committee shall constitute a quorum.

SEC. 5. The President shall be, *ex officio*, the nominee for American Member of the Council of the International Association.

Substitute:

SECTION 1. The officers shall be a President, a First Vice-President, a Second Vice-President, and a Secretary-Treasurer.

SEC. 2. These officers shall be elected by letter ballot at the Annual Meetings. The President shall hold office for one year. The two Vice-Presidents and the Secretary-Treasurer shall hold office for two years. The term of office of the First Vice-President and of the Secretary-Treasurer shall expire in the even years, and that of the Second Vice-President in the odd years.

SEC. 3. The Executive Committee shall consist of these officers and eight members, four being elected by letter ballot at each Annual Meeting. Four members of the Executive Committee shall constitute a quorum.

SEC. 4. The President, the two Vice-Presidents and the members of the Executive Committee shall be ineligible for re-election to the same office until at least one full term shall have elapsed after the end of their respective terms.

SEC. 5. The officers and members of the Executive Committee to hold office under these by-laws shall be as follows:

To hold office for one year:—the President elected this year (1912), the Second Vice-President, to be appointed by the Executive Committee, and the following members of the present Executive Committee: W. A. Bostwick, Robert W. Hunt, Richard Moldenke and William R. Webster.

To hold office for two years:—the First Vice-President elected this year (1912), the Secretary-Treasurer elected this year (1912), the three members of the Executive Committee elected this year (1912), and a fourth member to be appointed by the Executive Committee.

ARTICLE V. DUES.

Strike out:

SECTION 1. The fiscal year shall commence on the first of January. The annual dues shall be $10.00 for Members and $5.00 for Junior Members, payable in advance.

Substitute:

SECTION 1. The fiscal year shall commence on the first of January. The annual dues shall be $10.00 for Members and $5.00 for Junior Members payable in advance. Honorary Members shall not be subject to dues.

The tellers, Mr. Richard L. Humphrey and Mr. Jesse J. Shuman, appointed by the Chair to canvass the vote on the election of Officers and Members of the Executive Committee, reported that 363 legal ballots had been cast, and in accordance with their report the Chair declared the election of Mr. Robert W. Hunt, President; Mr. A. W. Gibbs, Vice-President; Mr. Edgar Marburg, Secretary-Treasurer; Mr. J. B. Lober, Mr. A. A. Stevenson and Mr. S. W. Stratton, members of the Executive Committee.

The meeting then adjourned till 3 P. M.

SECOND SESSION.—THURSDAY, MARCH 28, 3 P. M.

Mr. Henry M. Howe in the Chair.

The Chairman announced that Mr. Robert W. Hunt, the President-elect, had found it a physical impossibility to be present at the meeting, but that, fortunately, Mr. A. W. Gibbs, the Vice-President-elect, was present, and that he desired to call on him for a few remarks.

Mr. Gibbs expressed his appreciation of the honor that had been conferred upon him, and his hope and purpose to do what he could towards advancing the best interests of the Society.

In the absence of Mr. C. H. Zehnder, Chairman of Committee D-6 on Standard Specifications for Coke, the report of that Committee was presented by Mr. Albert Ladd Colby, Secretary.

Mr. S. V. Hunnings, Chairman of Committee A-2 on Standard Specifications for Wrought Iron, presented the report of that Committee embodying proposed Standard Specifications for:

Staybolt Iron;
Engine-bolt Iron;
Refined Wrought-iron Bars;
Iron Locomotive Boiler Tubes.

Certain amendments to these proposed standard specifications were recommended by the Committee and adopted; and the specifications as amended were, on motion, referred to letter ballot of the Society.

Mr. Wm. R. Webster, Chairman of Committee A-1 on Standard Specifications for Steel, presented the report of that Committee, embodying two proposed revised and eleven proposed new standard specifications, and proposed revisions in two existing standard specifications. It was decided that each specification should be considered separately.

Favorable action was taken on the following recommendations submitted by Committee A-1 in its annual report:

> "Committee A-1 desires to recommend that if the proposed Standard Specifications for Open-hearth Steel Girder and High Tee Rails should be referred to letter ballot of the Society, and adopted among the Standard Specifications of the Society, Committee E-5 shall be authorized to recast these specifications in conformity with the regulations adopted by that Committee.[1]
>
> "It is further recommended that in reprinting the other existing standard specifications for steel in the 1912 Yearbook, Committee E-5 shall be empowered to make similar changes in the form, as distinguished from the substance, of such specifications."

Mr. Webster, Chairman of Committee A-1, presented, on behalf of that Committee, the following addendum to the annual report of the Committee:

> "The Committee desires to announce its purpose to give careful consideration during the ensuing year to the revision

[1] See page 105.

of the present Standard Specifications for Bessemer and for Open-hearth Steel Rails, and that in that connection it hopes to cooperate with, and to receive the support of committees of other societies engaged in similar efforts, with a view of presenting the best possible recommendations at the next annual meeting of the Society."

After considerable discussion of the proposed amendments of the Standard Specifications for Steel Reinforcing Bars, Mr. E. E. Hughes moved that the proposed amendments be laid on the table. This motion was lost.

The Secretary moved that the proposed amendments be referred to letter ballot of the Society, with the express understanding that this action is not to be construed as being taken to the prejudice of any material not included in the proposed Standard Specifications for Steel Reinforcing Bars as amended. This motion was carried.

On the invitation of the Chairman, Mr. Robert W. Lesley then assumed the chair.

On motion, the proposed amendment of the Standard Specifications for Steel Splice Bars was referred to letter ballot of the Society.

Certain amendments to the following proposed new Standard Specifications were recommended by the Committee and adopted; and the specifications as amended were, on motion, referred to letter ballot of the Society:

For Structural Nickel Steel;
For Automobile Carbon and Alloy Steels,
For Open-hearth Steel Girder and High Tee Rails.

The meeting then adjourned till the following morning.

THIRD SESSION.—FRIDAY, MARCH 29, 10 A. M.

Mr. Henry M. Howe in the Chair.

Mr. L. W. Page, Chairman of Committee D-4 on Standard Tests for Road Materials, presented the report of that Committee, to which was appended a minority report by Mr. Clifford Richardson.

On motion, this report was referred to letter ballot of the Society.

The remaining proposed standard specifications presented by Committee A-1 were then considered. Certain amendments of the following proposed specifications were recommended by the Committee and adopted; and the specifications as amended were, on motion, referred to letter ballot of the Society:

PROPOSED REVISED SPECIFICATIONS.

For Heat-treated Carbon-steel Axles, Shafts, and Similar Objects.
For Steel Castings.
For Boiler and Firebox Steel.
For Boiler Rivet Steel.

PROPOSED NEW SPECIFICATIONS.

(*a*) *For Locomotive Materials.*

Annealed Steel Forgings.
Lap-welded and Seamless Steel Boiler Tubes and Safe Ends, $2\frac{1}{2}$ in. in Diameter and Under.
Steel Shapes, Universal Mill Plates, and Bars.

(*b*) *For Other Materials.*

Forged and Rolled, Forged, or Rolled Solid Carbon-steel Wheels for Engine-truck, Tender, and Passenger Railway Service.
Forged and Rolled, Forged, or Rolled Solid Carbon-steel Wheels for Freight-car Service.

On motion, the proposed Standard Specifications for Cold-rolled Steel Axles were ordered printed in the Proceedings for the information of the Society, as recommended by the Committee, after revision as to form by Committee E-5.

Mr. A. W. Carpenter called attention to the omission of elastic strength requirements in the Standard Specifications for Structural Steel for Bridges, and gave notice of his intention to address a communication on this subject to Committee A-1 on Standard Specifications for Steel, to recommend that this matter be given further consideration.

Mr. Henry S. Spackman offered the following motion:

"That the Executive Committee be requested to consider the advisability of submitting the standard specifications of the Society to the criticism of counsel with a view to determining their legal soundness."

This motion was carried.

The meeting then adjourned till 3 P. M.

FOURTH SESSION.—FRIDAY, MARCH 29, 3 P. M.

Mr. J. M. Goodell in the Chair.

In the absence of Mr. G. F. Swain, Chairman of Committee C-1 on Standard Specifications for Cement, the report of that Committee was presented by Mr. Richard L. Humphrey, Secretary.

Mr. Rudolph Hering, Chairman of Committee C-4 on Standard Tests and Specifications for Clay and Cement Sewer Pipes, reported progress in the work of that Committee.

In the absence of Mr. A. Marsten, Chairman of Committee C-6 on Standard Tests and Specifications for Drain Tile, the report of that Committee was presented by Mr. C. W. Boynton, a member of the Committee.

Mr. W. A. Aiken, Chairman of Committee D-8 on Waterproofing Materials, presented the report of that Committee. After considerable discussion, Mr. Richard L. Humphrey moved that the report be referred back to the Committee for further consideration. This motion was carried.

Mr. Leonard Waldo, Chairman of Committee E-3 on the Definition of the Term "Modulus of Elasticity" in its Application to Materials, including Non-Ferrous Metallic Metals and their Combinations, reported progress in the work of that Committee.

Mr. Richard L. Humphrey offered the following motion:

"That the Executive Committee be requested to consider the advisability of appointing a Committee on Petroleum Products to cooperate with the International Petroleum

Commission, the American Chemical Society, and the International Society of Applied Chemistry."

This motion was carried.

Mr. E. B. Tilt, Chairman of Committee D-11, on Standard Specifications for Rubber Products, announced the recent creation of this Committee, and its desire to receive helpful information from the membership of the Society at large.

The Chairman then declared the meeting adjourned *sine die*.

American Society for Testing Materials.

AFFILIATED WITH THE
INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS

PROCEEDINGS.

This Society is not responsible, as a body, for the statements and opinions advanced in its publications.

ANNUAL ADDRESS BY THE RETIRING PRESIDENT.

Henry M. Howe.

Standard International Specifications.

Since our last meeting an important and it is believed very favorable change has been made in the plan of campaign of those who seek to erect standard international specifications. At that time the step on which attention was most fixed was the so-called stamping plan, that certain important steel objects well fitted in their nature for forming the basis of international specifications should be chosen; that each of the more important producing countries should create, from the elements of its own current national specifications, a single representative national specification for each such object; and that the International Association for Testing Materials should then stamp on each of these standard national specifications its own certificate that that specification is well fitted for use in expert trade. The immediate purpose of this step was the simplification of the inevitably difficult and complex task of agreeing on a single international specification for each object. If we could create a small number of specifications thus standardized, each acceptable and familiar to the various manufacturers of one single

country, we should thereby simplify greatly the problem of devising a single international specification which would differ in the least degree and in the least objectionable manner from each one of this small number of specifications. The simplest form of this problem thus reached would be, it was hoped, also the easiest.

Recognizing the great merits of this certainly most attractive plan, some important parties in interest feared two things: First, that the agreement of the various manufacturers of a given nation on a single national specification would make them reluctant to accept in its place any other, even if that were an international one; that they would be more reluctant to give up a single clear national specification on which they had all agreed, than a mass of co-existing specifications, differing so confusingly that their very abandonment would be acceptable; and second, that the endorsement by so eminent a body as the International Association for Testing Materials of a series of individual national specifications would tend to give the impression that they were of equal merit, and that this false impression would give an improper advantage to the less stringent specifications, those which give the least protection to the buyers' interests.

The propositions now prominently under consideration seem to avoid these difficulties. The most important step recommended is the adoption at an early day of standard international specifications, not indirectly through the preliminary development of single national specifications, but directly, for three important classes of materials, structural steel for ships, for bridges, and for buildings. The specifications for structural steel for ships recommended are those now common to the British Engineering Standards Committee and to Lloyds' Register, supplemented by the chemical requirements of the American Society for Testing Materials. For bridge steel the specifications recommended are those of the American Society for Testing Materials, which, as I am credibly informed, are practically identical with those of the American Railway Engineering Association, the affiliations of which give to its specifications an importance of the very highest order. For building steel the specifications recommended are those of the American Society for Testing Materials, which are in general like its bridge steel

specifications save that they permit the use of Bessemer steel, and set a higher phosphorus limit.

The reception which these propositions have received is very encouraging, and leads one to believe that substantial progress in this very important direction has been made. To this Society it is most gratifying that its quasi representatives, the American members of the committee of the International Association for Testing Materials which has this matter in charge, have contributed in a very important degree to this progress. To them is due not only our own gratitude but that of mankind in general, for resolutely pushing forward this matter of such far-reaching importance, often in spite of most trying obstacles.

CHARACTERISTICS OF OUR SOCIETY.

The essential and very important difference between the works and ways of this Society and those of the vast majority of other scientific and technical societies ought to be kept prominently before us. Of course the ultimate purpose of all is supposed to be the benefit of mankind; but where others work indirectly, we work with a directness and immediate utility which stimulate our enthusiasm most highly. The chief work of most such societies is the increase and diffusion of knowledge by means of papers which set forth the results of special investigations made by their members. Many societies go so far as actually to prohibit, whether by written or by unwritten law, the direct service of the public through their own official acts. The energies even of those societies which do not thus set statutory limits to their usefulness are devoted chiefly to the indirect work of increasing and diffusing knowledge, and such direct action as they take is of very secondary importance.

But from the beginning our chief purpose has been the direct and immediate service of mankind. We have always been a going business concern. We saw that a great work lay ready at our hands, that not only of facilitating trade but of protecting the less well informed buyer from the necessarily better informed maker, and conversely by protecting the self-respecting manufacturer from the competition of the unscrupulous, ever too ready to prey on the ignorance or cupidity of the buyer. This we set out to do by using the expert knowledge of our members

for the purpose of making standard specifications, standards of justice and reasonableness, to which all could appeal from the demands of the unreasonable and unscrupulous. We have created sieves which pass the wheat but stop the chaff. The wonderful growth of the Society and the great devotion of its members to its often arduous work are due in very large part to the importance of this our service to the public, and to our great leader, Dr. Dudley, to whose lofty character were added all the essentials of leadership in such an undertaking, tact, a sympathetic power of inspiring enthusiasm, self-evident justice and reasonableness, a broad and far-seeing comprehension of the needs and the possibilities of the work, and an intimate, profound, and wide knowledge of the details of specifying and testing; in a word, the highest idealism, perfect familiarity with the subject, and the most astute practical wisdom.

NEW METHODS.

As the work of a going business concern progresses, it naturally finds new ways of increasing its own efficiency. Let me indicate four such ways which have lately opened before us.

First, the sub-division of the work of certain important committees through the creation of sub-committees, each working under its own chairman, yet so related that the knowledge and wisdom of the whole committee are brought to bear in scrutinizing the work of those sub-committees before it is laid before the Society. The great increase of efficiency which this subdivision leads us to expect appears in the present year's work of Committee A-1 through its thirteen sub-committees, a work far beyond what the Committee could possibly do if undivided.

Second, perfecting the form of the specifications drawn up by the various committees, and detecting gaps and other defects in them, by submitting them to a committee charged with this special work, and therefore bringing to it special skill and experience.

Third, the cooperation of certain committees with the corresponding ones in sister societies. This brings to each problem a wider point of view, additional knowledge, and the two heads proverbially wiser than one.

Fourth, the cooperation of the national government, which

is now to be represented not only on our Executive Committee, but also officially on several of our technical committees.

This brief survey of the late additions to our efficiency may suggest to us the breadth of our possibilities as yet unthought of. The widening of our work, the gains in efficiency, should continue and should accelerate, especially under the leadership of one who is a master of the details of testing and of specifications, our President-elect.

A president's address is, by precedent of doubtful wisdom, irresponsible, undebateable, and echoless; by courtesy his errors remain uncorrected and his fallacies unpricked. Though this is a form of *noblesse oblige* which should make him shun unpunishable faults, should make him wary lest he err, and should make him search out his thoughts for the lurking fallacy, yet it cannot, in my opinion, relieve him of the duty of disclosing to his society whatever convictions, pertinent to its welfare, have been forced upon him by his temporary familiarity with its work. We readily understand why Dickens courted the criticism of a child, and why every true artist will listen to thoughtful words from the uninformed point of view of the uninitiated.

The thought which these considerations lead me to lay before you, is that we should inquire carefully whether we are in part responsible for needless killing and maiming of our fellow citizens on our great national highways, the railroads. For needless killing there is a stronger word. Neither the Ten Commandments as a whole, nor the sixth in particular, will budge.

I am not in a position to know the merits of the case, or to say whether culpability actually exists anywhere, much less to apportion it. But if what is said on apparently good authority is even approximately true, then the reason to believe that there are very many preventable deaths and injuries on our railroads is so strong as to demand investigation on the part of all even remotely responsible, and to demand that those situated as we are should ask carefully whether we too are not in part responsible.

For a preventable death, for a death which I can prevent but do not, I am accountable. In that I do not prevent it I

permit it; my omission to prevent, my effective permission, determines the death. I am as responsible for my omissions as for my acts, if not before the law, certainly before God and man.

We set up standards for rails. It is strongly suspected and at times asserted that the breakage of these rails causes many needless deaths. If those rails are bought under our specifications, and if those specifications do not fully secure the very least attainable danger of breakage, we, as the experts on whose judgment these rails have been permitted, through their breakage, to kill our fellow men, are in a measure responsible. If the rails which imperil the lives of our fellows are bought not under our specifications but under looser and improper ones, then certain questions loom up. Are we, because of our expert knowledge of the manufacture, testing, and uses of rails, in a position to inform ourselves as to whether such specifications fail to protect our fellows thoroughly, and thus actually doom some of them to death? Such insufficient specifications are pistol shots fired indeed into a crowd and aimed at no individual, but none the less carrying death, and carrying it with the knowledge and the permission of those who could prevent it if they would. Has not our voice the power to be heard? Is not our competence to form a true judgment recognized? If yes, if preventable practices are now continuing which are going to kill many men, practices the dangerous nature of which we are in a position to recognize and convincingly to expose; if, under these conditions we omit to exert our power of detection and exposure, shall we not be in a measure responsible for those future deaths, as I am responsible in part for the death of a drowning man to whom I fail to throw the life belt in my hand? Is it not our duty to do overtly what lies in our power to save the lives and protect the bodies of our fellows? To determine what acts would be most effective would require very careful consideration, and a knowledge which I manifestly lack. A possible means is an offer of our aid to those on whom this problem is already pressing heavily, the public bodies charged with the legal duty of investigating and removing the supposed dangers, and those railroad officers and rail makers who not only from enlightened self interest but

also for humanity's sake we cannot doubt are studying this problem earnestly. We might aid effectively even if we did no more than clarify the enunciation of the problem. Our natural dread is that it should be regarded as the problem of giving such safety as is consistent with what are called modern conditions, very heavy wheel loads, very large train units, and very high speed. If we could help to have the problem looked at more generally from the opposite point of view, that the weight of wheel loads, the size of train units, and the speed of express trains ought to be as great and only as great as is consistent with the least danger to human life—even if that were all that we could do, it might be well worth doing.

It is idle to plead that the fault lies primarily elsewhere; that the railroads are in part to blame, and the traveling public in part, because of its inconsiderate demands for unsafe speed. My duty towards the drowning man is unaffected by his having come into the water through his own fault or that of another; it is unlessened by the apathy of the police and of the other onlookers. My duty is my duty. It depends solely on my own conditions and powers, and not on the faults of others.

The question then seems to resolve itself into these. First, is there a considerable number of rail breakages capable of prevention by means of better specifications? Second, can we contribute directly or indirectly toward bettering those specifications by directing attention to their present defects? I commend these questions to your thoughtful consideration.

REPORT OF COMMITTEE A-1

ON

STANDARD SPECIFICATIONS FOR STEEL.

During the past year the membership of Committee A-1 has been increased with a view of distributing the work among numerous sub-committees, each consisting of members selected especially for their qualifications for effective service in the respective fields of the various sub-committees. The membership of Committee A-1 is now 70, and sub-committees have been created in connection with specifications for the following materials:

I. Steel Rails and Splice Bars.
   - (*a*) Bessemer Rails.
   - (*b*) Open-hearth Rails.
   - (*c*) Girder Rails.
   - (*d*) Splice Bars.

II. Structural Steel.
   - (*a*) For Bridges.
     1. Carbon Steel.
     2. Nickel Steel.
   - (*b*) For Buildings.

III. Structual Steel for Ships.
IV. Spring Steel.
V. Steel Reinforcing Bars.
VI. Steel Axles.
   - (*a*) Car and Tender Truck Axles.
   - (*b*) Driving and Engine Axles.
     1. Carbon Steel.
     2. Nickel Steel.
   - (*c*) Heat-treated Axles.
   - (*d*) Cold-rolled Axles.

VII. Rolled Steel Wheels and Tires.

(*a*) Wheels for Engine-truck, Tender, Passenger, and Motor Railway Service.
(*b*) Wheels for Freight-car Service.
(*c*) Tires.

VIII. Steel Forgings.
IX. Steel Castings.
X. Steel Tubing.
XI. Automobile Steels.
XII. Locomotive Materials.

(*a*) Boiler and Firebox Steel.
(*b*) Boiler Rivet Steel.
(*c*) Annealed Steel Forgings.
(*d*) Lap-welded Steel Boiler Tubes and Safe Ends.
(*e*) Steel Shapes, Universal Mill Plates, and Bars.

XIII. Steel Forging Blooms, Billets and Slabs.

Another sub-committee was originally appointed to prepare specifications for steel wire. This sub-committee has been discharged, however, in pursuance of the following report, in which every member of the sub-committee in question concurred:

"Your Sub-Committee on Standard Specifications for Steel Wire has carefully considered the subject of drafting specifications governing the chemical and physical properties of steel wire. The discussion developed the fact that hundreds of grades and treatments of wire were required to meet the demands of a widely diversified trade. In view of this situation, it was the unanimous opinion of the Committee that in the present state of the industry, it is inadvisable, if not impossible, to draft practical specifications covering even a small percentage of the great variety of products required by the trade."

The plan of organization outlined above has rendered it possible to do a large amount of work during the past year without entailing too heavy a burden on the individual members of the general committee.

The substance of this report of Committee A-1 is embodied chiefly in the Appendix covering two proposed revised specifications and eleven proposed new specifications on the following subjects:

PROPOSED REVISED SPECIFICATIONS.

1. For Heat-treated Carbon-steel Axles, Shafts and Similar Objects.
2. For Steel Castings.

PROPOSED NEW SPECIFICATIONS.

(a) For Locomotive Materials.

1. Boiler and Firebox Steel.[1]
2. Boiler Rivet Steel.[1]
3. Annealed Steel Forgings.
4. Lap-welded and Seamless Steel Boiler Tubes and Safe Ends, $2\frac{1}{2}$ in. Diameter and Under.
5. Steel Shapes, Universal Mill Plates, and Bars.

(b) For Other Materials.

6. Forged and Rolled, Forged, or Rolled Solid Carbon-steel Wheels for Engine-truck, Tender, and Passenger Service.
7. Forged and Rolled, Forged, or Rolled Solid Carbon-steel Wheels for Freight-car Service.
8. Structural Nickel Steel.
9. Automobile Carbon and Alloy Steels.
10. Open-hearth Steel Girder and High Tee Rails.
11. Cold-rolled Steel Axles.

Committee A-1 recommends that the above thirteen specifications be referred to letter ballot of the Society, with the exception of the proposed Standard Specifications for Cold-rolled Steel Axles. It is recommended that the last be printed in the Proceedings with a view of their presentation at the next annual meeting of the Society for adoption in their present or modified form, in the light of such further information as may become available during the year.

Committee A-1 further recommends the following changes in two other specifications, namely:

[1] These specifications, although prepared by Sub-Committee XII on Locomotive Materials, are designed to be applicable to stationary boiler material in general and to supersede the present Standard Specifications for Open-hearth Boiler Plate and Rivet Steel.

1. *Standard Specifications for Steel Splice Bars.*

It is proposed that in Section 3 of these specifications the limits for tensile strength, in pounds per square inch, shall be changed from "54,000 to 64,000" to "55,000 to 65,000."

2. *Standard Specifications for Steel Reinforcing Bars.*

It is proposed that Section 1 of these specifications shall be changed from the present form:

"1. Steel may be made by either the open-hearth or Bessemer process. Bars shall be rolled from billets,"

to the following form:

"3. (*a*) The steel may be made by the Bessemer or the open-hearth process.

"(*b*) Bars shall be rolled from new billets. No re-rolled material will be accepted."

The proposals for changes in certain existing specifications and the proposed new specifications have all originated in the various sub-committees. These specifications were then thoroughly discussed and amended at a largely attended meeting of Committee A-1, and referred to letter ballot of that Committee. That letter ballot has resulted favorably, and the specifications are now submitted to the Society for action as above recommended.

For the information of the Society it is thought desirable to offer the following comments:

PROPOSED REVISIONS IN EXISTING SPECIFICATIONS.

FOR HEAT-TREATED CARBON-STEEL AXLES, SHAFTS, AND SIMILAR OBJECTS.

The principal proposed changes in these specifications are:

In Section 7 (now Section 8), it has been specified that the mandrel for the bend tests shall be 1 in. thick, and its form has been indicated by a figure. It has also been stated that the tests may be made by pressure or by blows.

In Section 10 (now Section 3), the words "to become cold" have been

substituted for the words "to cool," and the words "allowed to cool" after the word "medium" have been omitted.

In Section 13 (now Section 12), the words "axle collars" have been substituted for the word "collar," and the words "unless otherwise specified" have been inserted at the beginning of the section.

Section 15 (now Sections 15, 16 and 17) has been changed to the standard form of the section covering inspection and rejection, as embodied in the proposed specifications for annealed steel forgings and for rolled wheels.

Certain changes in form (not substance) have been made in conformity with the regulations of Committee E-5.

FOR STEEL CASTINGS.

The principal proposed changes in these specifications are:

Patterns.—The insertion of a clause with reference to the preparation and painting of patterns.

Process of Manufacture.—The section relating to the process of manufacture has been changed to include so-called "converter steel," which does not run as high in phosphorus as ordinary grades of Bessemer steel.

Annealing has been specified only for castings for which there are physical requirements, as it is often a detriment in other cases on account of warping, making the castings too soft, or unnecessary expense.

Chemical Properties.—The maximum limit for carbon, for castings not subject to physical tests, has been reduced from 0.40 to 0.30, at the request of certain members of Committee A-1 representing railroad interests.

A variation of 20 per cent for check analyses of phosphorus and sulphur have been provided for, since this is absolutely necessary in order that the specifications may not be unduly burdensome to Western foundries, which have great trouble in securing low phosphorus, and to Eastern foundries, which have similar trouble with respect to sulphur. It has been specified that drillings from annealed castings shall be taken at least $\frac{1}{4}$ in. from the surface, on account of the reduction in carbon and the increase in sulphur sometimes caused in the skin of castings by annealing.

Physical Properties.—It has been specified that all test specimens shall be cut from test bars, which shall, if possible, be attached to the casting. On account of the great variations in size and design, it is impossible to state more definitely where these bars shall be attached than that the manufacturer and purchaser shall agree on their location. It is unfair to cut tests from the sinkhead as provided in the present specifications.

The tensile strength and yield point for hard castings have been lowered slightly to make an even range of figures and to bring them into better accord with the specified elongation and reduction of area.

The percussive test has been omitted, as it is practically obsolete. In addition to being expensive, it does not meet the requirements.

A clause has been inserted to provide for additional tests if the tests fail on account of flaws in the test pieces. A similar clause exists in Lloyd's and other specifications.

Finish.—This section has been changed to make it shorter and more effective.

Certain changes in form (not substance) have been made in conformity with the regulations of Committee E–5.

FOR STEEL SPLICE BARS.

The proposed change is recommended in order to make the requirement for tensile strength in these specifications consistent with similar requirements in the Standard Specifications for Structural Steel for Bridges.

FOR STEEL REINFORCING BARS.

The proposed changes are recommended with a view of making it clear that the specifications are not intended to be applicable to reinforcing bars made from re-rolled material.

PROPOSED NEW SPECIFICATIONS.

FOR LOCOMOTIVE MATERIALS.

The five proposed new specifications have been framed by a sub-committee under the chairmanship of Mr. F. J. Cole (with the cooperation of Sub-Committee X on Steel Tubing) with a view to meeting the special requirements for locomotives. It is anticipated that additional specifications under that heading will be presented at the next annual meeting of the Society. It is understood that Committee A-2 on Standard Specifications for Wrought Iron will present at this meeting proposed Standard Specifications for Staybolt Iron, especially applicable to locomotives, and designed to supersede the present Standard Specifications for Staybolt Iron.

FOR ROLLED STEEL WHEELS.

The proposed changes in these specifications as printed in the Proceedings of 1911 (pp. 55-62) are:

(A) Passenger Service.

Chemical Composition.—The carbon range has been reduced to 0.20 and the manganese range to 0.25 per cent. The requirements for silicon have been made 0.15 to 0.35 per cent for acid and 0.10 to 0.30 per cent for basic steel.

Tolerances.—Referring to Section 7 (now Section 5):

(*a*) *Height of Flange.*—The original wording, "shall not vary more than $\frac{1}{16}$ in. over nor more than $\frac{1}{32}$ in. under that specified," has been changed to read, "shall not vary more than $\frac{1}{8}$ in. over that specified."

(*g*) *Limit Groove.*—The dimension at the thinnest point has been changed from $\frac{11}{16}$ in. to $\frac{3}{4}$ in.

(*i*) *Diameter of Hub.*—Requirements for minimum thickness of hub for bores over 7 in. in diameter have been added.

(*l*) *Black Spots in Hub.*—The original wording, "Black spots in the rough bore shall not be longer than 2 in. nor deeper than $\frac{1}{8}$ in. Black spots longer than 2 in. or deeper than $\frac{1}{16}$ in. will not be permitted in the rough bore within 2 in. of either face," has been changed to read, "Black spots deeper than $\frac{1}{16}$ in. will not be permitted in rough bore within 2 in. of either face of the hub."

(*m*) *Eccentricity of Bore.*—The eccentricity between the tread at its center line and the rough bore has been changed from $\frac{1}{16}$ in. to $\frac{3}{64}$ in.

(*B*) *Freight Service.*

Chemical Composition.—Same as Passenger Service.

Tolerances.—Referring to Section 7 (now Section 5):

(*a*) *Height of Flange.*—Same as Passenger Service.

(*e*) *Width of Rim.*—The original wording, "shall not be more than $\frac{1}{8}$ in. less nor more than $\frac{1}{4}$ in. over that specified," has been changed to read, "shall not vary more than $\frac{1}{8}$ in. from that specified."

(*g*) *Limit Groove.*—Same as Passenger Service.

(*i*) *Diameter of Hub.*—Same as Passenger Service.

(*l*) *Black Spots in Hub.*—Same as Passenger Service.

(*m*) *Eccentricity of Bore.*—Same as Passenger Service.

(*p*) *Plane.*—The limit in variation has been changed from $\frac{3}{32}$ in. to $\frac{1}{16}$ in.

FOR STRUCTURAL NICKEL STEEL.

These specifications are substantially an adaptation of the specifications for nickel steel prepared by Messrs. Boller and Hodge in connection with the design of the Municipal Bridge across the Mississippi at St. Louis, and have been framed by a sub-committee under the chairmanship of Mr. H. W. Hodge.

FOR AUTOMOBILE CARBON AND ALLOY STEELS.

These specifications were prepared by a sub-committee under the chairmanship of Mr. Albert Ladd Colby consisting of twenty members, numerically balanced between the principal producers and consumers of American automobile steels.

The chemical requirements of these specifications are identical, with few exceptions, with those in the specifications for

automobile steels received and ordered to be printed by the Society of Automobile Engineers at its annual meeting on January 18, 1912, as "Standards recommended by the Committee." These specifications were submitted to that Society as the Third Report of the Iron and Steel Division of which Mr. Henry Souther, ex-President of the Society of Automobile Engineers, is Chairman, and of which Mr. C. F. Clarkson, General Manager of that Society, is Secretary.

These specifications, as now presented, conform to the standards of this Society and include definite requirements as to the basis of purchase and testing by check analysis, as well as the location and number of tension and bend test specimens. The proposed Standard Specifications for Class "B" Steel Castings, prepared by another sub-committee, is recommended for adoption as a part of the automobile steel specifications.

In conclusion, attention is directed to the fact that, with the exception of the proposed Standard Specifications for Open-hearth Steel Girder and High Tee Rails, all of the specifications appended to this report have been drawn up in a form consistent with the recommendations of Committee E-5 on Rules Governing the Form but not the Substance of Specifications, which, it is understood, will be embodied in the report of that Committee to be presented at this meeting. Committee A-1 desires to recommend that if the proposed Standard Specifications for Open-hearth Steel Girder and High Tee Rails should be referred to letter ballot of the Society, and adopted among the Standard Specifications of the Society, Committee E-5 shall be authorized to recast these specifications in conformity with the regulations adopted by that Committee. It is further recommended that in reprinting the other existing standard specifications for steel in the 1912 Year-book, Committee E-5 shall be empowered to make similar changes in the form, as distinguished from the substance, of such specifications.

Respectfully submitted on behalf of the Committee,

Wm. R. Webster,
Chairman

Edgar Marburg,
Secretary.

ADDENDUM.

By authorization of Committee A-1 the Chairman, Mr. Wm. R. Webster, presented the following addendum in submitting the above report at the annual meeting:

> "The Committee desires to announce its purpose to give careful consideration during the ensuing year to the revision of the present Standard Specifications for Bessemer and for Open-hearth Steel Rails, and that in that connection it hopes to cooperate with, and to receive the support of committees of other societies engaged in similar efforts, with a view of presenting the best possible recommendations at the next annual meeting of the Society."

NOTE.—The appendix to the report of Committee A-1 is not reprinted here. The action at the annual meeting, relative to the specifications in the appendix, is summarized following this report.—ED.

ACTION

ON

THE REPORT OF COMMITTEE A-1.

The following amendments of the proposed revised and new specifications as presented at the annual meeting by Committee A-1 were adopted at that meeting. These specifications as thus amended were adopted by letter ballot of the Society canvassed on June 1, 1912.

Heat-treated Carbon-steel Axles.[1]

1. *Section 3.*—After "grain" in the third line, insert the following in parentheses:

> "a group thus reheated being known as a 'quenching charge'".

2. *Section 10* (now Section 11).—Change,

> "One tension and one bend test shall be made from each treating-plant heat; if more than one melt is represented in a treating-plant heat, one tension and one bend test shall be made from each melt.",

to read,

> "One tension and one bend test shall be made from each annealing charge. If more than one quenching charge is represented in an annealing charge, one tension and one bend test shall be made from each quenching charge. If more than one melt is represented in a quenching charge, one tension and one bend test shall be made from each melt."

3. *Section 11* (now Section 12).—Before "lot" in the first and fourth lines, insert "test". After "re-treat" in the third line, insert "each".

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[1] For these specifications in revised form see pages 169–173.—Ed.

4. *Section 16* (*a*) (now Section 17 (*a*)).—Change the clause,

"and returned to the manufacturer, who shall pay return freight.",

to read,

"and the manufacturer shall be notified."

5. *Section 16* (*b*) (now Section 17 (*b*)).—Change "two" in the third line to "five".

STEEL CASTINGS.[1]

1. *Section 8* (now Section 9).—Omit the sentence, "Bend tests may be made by pressure or by blows."

2. *Section 12* (now Section 14 (*b*)).—Change the sentence,

"The castings shall be painted at the option of the purchaser.",

to read,

"The castings offered for inspection shall not be painted or covered with any substance that will hide defects, nor rusted to such an extent as to hide defects."

3. *Section 14* (now Section 16).—Change the clause,

"and returned to the manufacturer, who shall pay return freight.",

to read,

"and the manufacturer shall be notified."

BOILER AND FIREBOX STEEL.[2]

1. *Section 3*.—Add a carbon requirement for firebox steel of 0.12–0.25 per cent.

2. *Section 5* (now Section 6 (*a*)).—Insert "min." (minimum) after "yield point" and "elongation in 8 in." in the table.

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[1] For these specifications in revised form see pages 192–195.—ED.

[2] For these specifications in revised form see pages 152–156.—ED.

3. *Section 7* (*c*) (now Section 8 (*a*) and (*b*)).—Change the sentence,

> "For material less than $\frac{3}{4}$ in. in thickness, flat on themselves; for material $\frac{3}{4}$ to $1\frac{1}{4}$ in. in thickness, around a pin the diameter of which is equal to $1\frac{1}{2}$ times the thickness of the specimen; and for material over $1\frac{1}{4}$ in. in thickness, around a pin the diameter of which is equal to twice the thickness of the specimen.",

to read,

> "For material 1 in. or under in thickness, flat on itself; and for material over 1 in. in thickness, around a pin the diameter of which is equal to the thickness of the specimen."

4. *Section 13* (now Section 14).—Change the words,

> "and lowest tensile strength specified,",

to read,

> "and lowest tensile strength for its grade specified in Section 6."

BOILER RIVET STEEL.[1]

1. *Section 2*.—Change the requirements for sulphur from "not over 0.04 per cent" to "not over 0.045 per cent".

2. *Section 4* (now Section 5 (*a*)).—Insert "min." (minimum) after "yield point" and "elongation in 8 in." in the table.

3. *Section 12* (now Section 14).—Change,

> "Rivets will be tested to a gage length of not less than four times the diameter, as shown in Fig. 1. The percentage of elongation shall not be less than that specified in Section 4.",

to read,

> "The rivets, if tested, shall conform to the requirements as to tensile properties specified in Section 5, except that the elongation shall be measured on a gage length not less than four times the diameter of the rivet."

[1] For these specifications in revised form see pages 157–160.—ED.

4. Omit Fig. 1.

5. *Section 13* (now Section 15).—Omit the first two lines, reading "Rivets from each lot offered, selected by the inspector, shall stand the following tests:".

(Renumber Sections 13 (*a*) and (*b*), 15 and 16.)

6. Insert the following Section 17:

"(*a*) If the results of the tension tests of the bars from which the rivets are made cannot be furnished, one tension test from each size in each lot offered for inspection shall be made.

"(*b*) Three bend and three flattening tests shall be made from each size in each lot of rivets offered for inspection."

7. *Section 15* (now Section 20).—Change,

"Rivets which fail to meet the requirements specified in Sections 12 and 13 will be rejected and returned to the manufacturer, who shall pay return freight.",

to read,

"Rivets which fail to conform to the requirements specified in Sections 14, 15 and 16 will be rejected, and the manufacturer shall be notified."

ANNEALED STEEL FORGINGS.[1]

Section 14 (now Section 15).—Change "two" in the third line to "five".

LAP-WELDED AND SEAMLESS STEEL BOILER TUBES.[2]

1. *Title.*—Insert the words "and seamless" after "lap-welded".

2. *Section 4.*—Omit Section 4 on "Expansion Tests," as follows:

"Coupons 8 in. long, cut from a tube, with or without heating, shall be placed in a vertical position and a smooth

[1] For these specifications in revised form see pages 250–253.—ED.

[2] For these specifications in revised form see pages 258–260.—ED.

tapered steel pin forced into the end of the tube. Under this test the tube shall expand to $1\frac{1}{6}$ times its original diameter without splitting or cracking. The pin shall be of tool steel and shall have a taper of $1\frac{1}{2}$ in. per foot of length. When this test is made hot, the tube shall be heated to a light cherry red as seen in the dark (not less than 1200° F.) and the pin at a blue heat (not less than 600° F.) forced in as described."

3. Change Sections 5 to 8, as follows:

"5. For tubes $1\frac{3}{4}$ in. in diameter or over, coupons 8 in. long, cut from the tube, shall have a flange $\frac{3}{8}$ in. wide turned over at right angles to the body of the tube without showing cracks or flaws. For tubes less than $1\frac{3}{4}$ in. in diameter, the width of flange shall be $\frac{1}{6}$ the diameter of the tube. All tests shall be made cold.

"6. A section 4 in. long shall stand hammering flat, cold, until the inside walls are in contact, without cracking at the edges or elsewhere. Care shall be taken that the weld is not located at the point of maximum bending.

"7. Coupons $2\frac{1}{2}$ in. long, cut from a tube, shall stand hammering longitudinally into the shape of a ring without showing cracks or flaws when crushed flat.

"8. Each tube of Nos. 9, 10, and 11 B.w.g. shall be subjected by the manufacturer to an internal hydraulic pressure of 1000 lb. per sq. in. Each tube of Nos. 12 and 13 B.w.g. shall be subjected by the manufacturer to an internal hydraulic pressure of 900 lb. per sq. in.",

to Sections 4 to 7, to read as follows:

"4. A test specimen not less than 4 in. in length shall have a flange $\frac{3}{8}$ in. wide turned over at right angles to the body of the tube without showing cracks or flaws.

"5. A test specimen 4 in. in length shall stand hammering flat until the inside walls are in contact, without cracking at the edges or elsewhere. For lap-welded tubes, care shall be taken that the weld is not located at the point of maximum bending.

"6. A test specimen $2\frac{1}{2}$ in. in length shall stand crushing flat longitudinally without showing cracks or flaws.

"7. Tubes of Nos. 9, 10, and 11 B.w.g. shall stand an internal hydraulic pressure of 1000 lb. per sq. in., and

tubes of Nos. 12 and 13 B.w.g. an internal hydraulic pressure of 900 lb. per sq. in."

4. Insert the following Section 8:

"8. (*a*) Test specimens shall consist of sections cut from a tube. They shall be smooth on the ends and free from burrs.

"(*b*) All specimens shall be tested cold."

5. *Section 10.*—Change,

"(*a*) If only one of the tubes fails to meet the requirements of Sections 4, 5, 6 or 7, that tube will be rejected; and the inspector will take two more from the same lot and subject both to the same tests as the one that failed. Both of these tubes shall be found satisfactory in order that the lot may be passed.

"(*b*) Tubes which fail to meet the requirements of Section 8 will be rejected.",

to read,

"If the results of the physical tests of only one tube do not conform to the requirements specified in Sections 4, 5, or 6, retests of two additional tubes from the same lot shall be made and each of these shall conform to the requirements specified."

6. *Section 13.*—Change,

"The finished tubes shall be circular within 0.02 in. and the mean diameter shall be within 0.015 in. of the size ordered. They shall be within 0.01 in. of the thickness specified, except at the weld, where an additional thickness of 0.015 in. shall be allowed. They shall not be shorter than the length ordered, but may exceed this by 0.125 in.",

to read,

"(*a*) The finished tubes shall be circular within 0.02 in. and the mean outside diameter shall not vary more than 0.015 in. from the size ordered. They shall not be shorter than the length ordered, but may exceed it by 0.125 in.

"(*b*) For lap-welded tubes, the thickness at any point shall not vary more than 0.01 in. from that specified, except

at the weld, where an additional thickness of 0.015 in. shall be allowed.

"For seamless tubes, the thickness at any point shall not vary more than 10 per cent from that specified."

7. *Section 17.*—Change the clause,

"and returned to the manufacturer, who shall pay return freight.",

to read,

"and the manufacturer shall be notified."

STEEL SHAPES, UNIVERSAL MILL PLATES, AND BARS.[1]

1. Add the following Sections 3 and 4 under "Chemical Properties and Tests," and renumber the remaining Sections accordingly:

"3. To determine whether the material conforms to the requirements specified in Section 2, an analysis shall be made by the manufacturer from a test ingot taken during the pouring of each melt. A copy of this analysis shall be given to the purchaser or his representative.

"4. A check analysis may be made by the purchaser from finished material representing each melt, and this analysis shall conform to the requirements specified in Section 2."

2. *Section 3* (now Section 5 (*a*)).—Insert "min." (minimum) after "yield point" and "elongation in 8 in." in the table.

3. *Section 4* (*a*) (now Section 6 (*a*)).—Add the words, "to a minimum of 20 per cent.", at the end of the Section.

4. *Section 7* (now Section 9 (*b*)).—Insert the sentence, "The sheared edges of bend test specimens shall be milled or planed.", at the end of the Section.

5. *Section 12* (*b*) (now Section 15).—Change the clause,

"and returned to the manufacturer, who shall pay return freight.",

to read,

"and the manufacturer shall be notified.

[1] For these specifications in revised form see pages 254–257.—ED.

ROLLED STEEL WHEELS FOR PASSENGER SERVICE.[1]

1. *Title.*—Insert "carbon" before "steel"; omit the words "and Motor Railway".

2. *Section 5 (g)* (now Section 6 (*g*)).—In the third line, change "$\frac{1}{16}$ in." to "$\frac{1}{8}$ in."

3. *Section 5 (k-3).*—Omit Section 5 (*k-3*), as follows:

"*Depression and Projection of Hub.*—For motor wheels, the depression of hub from the front face of the rim shall not be less, but may be $\frac{1}{8}$ in. more than that specified. The projection of hub from the back face of the rim shall not vary more than $\frac{1}{32}$ in. over nor more than $\frac{1}{16}$ in. under that specified."

4. *Section 10* (now Section 11).—Change "two" in the third line to "five."

ROLLED STEEL WHEELS FOR FREIGHT-CAR SERVICE.[2]

1. *Title.*—Insert "Carbon" before "steel."

2. *Section 5 (g)* (now Section 6 (*g*)).—In the third line, change "$\frac{1}{16}$ in." to "$\frac{1}{8}$ in."

3. *Section 10* (now Section 11).—Change "two" in the third line to "five."

STRUCTURAL NICKEL STEEL.[3]

1. *Section 5* (now Section 6 (*a*)).—Change the requirements for elongation from,

	Rivets.	Plates and Shapes.	Bars and Rollers, Unannealed.	Bars[a] and Pins, Annealed.
Elongation in 8 in., min., per cent	22	16[b]	16[c]	20[d]

[1] For these specifications in revised form see pages 174–178.—ED.
[2] For these specifications in revised form see pages 179–183.—ED.
[3] For these specifications in revised form see pages 135–140.—ED.

to read as follows:

	Rivets.	Plates and Shapes.	Bars and Rollers,[c] Unannealed.	Bars[d] and Pins,[c] Annealed.
Elongation in 8 in., min., per cent	1 500 000 / Tens. str.	1 500 000[b] / Tens. str.	1 500 000[b] / Tens. str.	20
Elongation in 2 in., min., per cent	.....	.....	16	20

In footnote *c*, omit "for rollers". Omit footnote *d*.

2. *Section 6* (now Section 7).—In the first line, omit "and" after "plates"; insert the words "and unannealed bars" after "shapes."

AUTOMOBILE CARBON AND ALLOY STEELS.[1]

1. *Section 5.*—Insert Table III, on Automobile Nickel Vanadium Steels, under "Title;" and change Tables III-VII to Tables IV–VIII.

Wherever it occurs, change "Table VII" to read "Table VIII."

2. *Section 16.*—Change the last clause,

> "two additional tests may be made to determine the suitability of the material.",

to read,

> "two retests shall be made and each of these shall conform to the requirements specified."

3. *Appendix.*—In Table I, change the permissible range in carbon for 0.60-per cent carbon steel, from "0.55–0.65" to "0.55–0.70."

In Table I, under "Steel Castings, Class B.", omit requirements for phosphorus and sulphur, and insert the words "the chemical and" after "for" in the first line. Omit the words "Sections 5 and 6".

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[1] For these specifications in revised form see pages 196–203.—ED.

After Table II, insert the following Table III; change Tables III–VII following, to Tables IV–VIII.

TABLE III.—AUTOMOBILE NICKEL-VANADIUM STEELS.

CARBON.		MANGANESE.		PHOS.	SULPH.	NICKEL.		VANADIUM.	
Desired.	Permissible Range.	Desired.	Permissible Range.	Not Over	Not Over	Desired.	Permissible Range.	Desired.	Not Under
0.15	0.10–0.20	0.65	0.50–0.80	0.040	0.040	3.50	3.25–3.75	0.18	0.12
0.20	0.15–0.25	"	" "	"	"	"	" "	"	"
0.25	0.20–0.30	"	" "	"	"	"	" "	"	"
0.30	0.25–0.35	"	" "	"	"	"	" "	"	"
0.35	0.30–0.40	"	" "	"	"	"	" "	"	"
0.40	0.35–0.45	"	" "	"	"	"	" "	"	"
0.45	0.40–0.50	"	" "	"	"	"	" "	"	"
0.50	0.45–0.55	"	" "	"	"	"	" "	"	"

All values are expressed in per cent.

In Table VII (now Table VIII), under "Valve Metal No. 2" insert the sentence, "The remainder shall be iron."

OPEN-HEARTH STEEL GIRDER AND HIGH TEE RAILS.[1]

1. *Section 3* (now Section 4).—After "composition," add the words, "as specified in the order:".

2. *Section 14 (b)* (now Section 7 (*a*)).—In the table, change the words, "Weight of Rail per yard.", to read "Weight and Height of Rail."

In the first line of the table, change "or" to "and." In the last line, insert "or" before "7 in."

The following amendments of previously existing specifications were also referred to letter ballot of the Society which resulted favorably to their adoption.

STEEL SPLICE BARS.[2]

1. *Section 3* (now Section 4 (*a*)).—Change the requirements as to tensile strength from "54,000 to 64,000" to "55,000 to 65,000."

[1] For these specifications in revised form see pages 122–126.—ED.

[2] For these specifications in revised form see pages 127–128.—ED.

STEEL REINFORCING BARS.[1]

1. *Section 1* (now Section 3 (*a*)).—Change,

"Steel may be made by either the open-hearth or Bessemer process. Bars shall be rolled from billets."

to read,

"3. (*a*) The steel may be made by the Bessemer or the open-hearth process.

"(*b*) Bars shall be rolled from new billets. No re-rolled material will be accepted."

Favorable action was taken on the following recommendations offered by Committee A-1:

"Committee A-1 desires to recommend that if the proposed Standard Specifications for Open-hearth Steel Girder and High Tee Rails should be referred to letter ballot of the Society, and adopted among the Standard Specifications of the Society, Committee E-5 shall be authorized to recast these specifications[2] in conformity with the regulations adopted by that Committee.[3]

"It is further recommended that in reprinting the other existing standard specifications for steel in the 1912 Yearbook, Committee E-5 shall be empowered to make similar changes in the form, as distinguished from the substance, of such specifications."

The proposed Standard Specifications for Cold-rolled Steel Axles were, on recommendation of Committee A-1, ordered printed in the Proceedings for the information of the Society, after revision as to form by Committee E-5.[4]

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[1] For these specifications in revised form see pages 161–164.—ED.

[2] For these specifications in revised form see pages 122–126.—ED.

[3] For these regulations see pages 105–113.—ED.

[4] For these specifications in revised form see pages 48–51.—ED.

AMERICAN SOCIETY FOR TESTING MATERIALS

PHILADELPHIA PA., U. S. A.

AFFILIATED WITH THE

INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.

PROPOSED STANDARD SPECIFICATIONS

FOR

COLD-ROLLED STEEL AXLES.

I. MANUFACTURE.

Process.

1. (*a*) The steel may be made by the open-hearth or by any other approved process.

(*b*) The axles shall be cold-rolled to finished size from hot-rolled bars.

Discard.

2. A sufficient discard shall be made from the top of each ingot to insure freedom from injurious piping and undue segregation.

II. CHEMICAL PROPERTIES AND TESTS.

Chemical Composition.

3. The steel shall conform to the following requirements as to chemical composition:

Carbon	not over 0.40 per cent
Manganese	0.40 – 0.80 "
Phosphorus	not over 0.05 "
Sulphur	" " 0.05 "

Chemical Analyses.

4. An analysis shall be made from one axle representing each melt, and this analysis shall conform to the requirements specified in Section 3. Drillings for analysis shall be taken from the crop end, parallel to the axis, at any point one-half the distance from the center to the surface.

In addition to the complete analysis, a phosphorus determination may be made by the purchaser from each broken tension test specimen, and this determination shall conform to the requirements for phosphorus specified in Section 3.

III. PHYSICAL PROPERTIES AND TESTS.

Tension Tests.

5. (*a*) The steel shall conform to the following minimum requirements as to tensile properties:

Tensile strength, lb. per sq. in.	70 000
Elastic limit, " "	60 000
Elongation in 2 in., per cent	18
Reduction of area, "	35

(*b*) The elastic limit shall be determined by means of an extensometer.

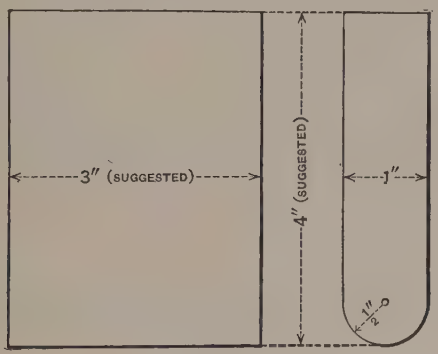

FIG. 1.

Bend Tests.

6. (*a*) The test specimen shall bend cold through 180 deg. around a 1-in. flat mandrel having a rounded edge of $\frac{1}{2}$-in. radius, without fracture on the outside of the bent portion. The form and suggested dimensions of the mandrel are shown in Fig. 1.

(*b*) Bend tests may be made by pressure or by blows.

Test Specimens.

7. (*a*) Tension and bend test specimens shall be taken from the crop end of the axle. The axis of the specimen shall be located at any point one-half the distance from the center to the surface and shall be parallel to the axis of the axle.

(*b*) Tension test specimens shall be of the form and dimensions shown in Fig. 2.

Bend test specimens shall be $\frac{1}{2}$ in. square in section, and shall not exceed 6 in. in length.

Number of Tests. 8. One tension and one bend test shall be made from each lot of 50 axles or less from each melt.

IV. WORKMANSHIP AND FINISH.

Workmanship. 9. The axles shall conform in sizes and shapes to the requirements given on the order of the purchaser or the drawing sent with it, and shall not vary more than 0.002 in. from the diameter specified. In centering, 60-deg. centers with clearance drilled at point shall be used.

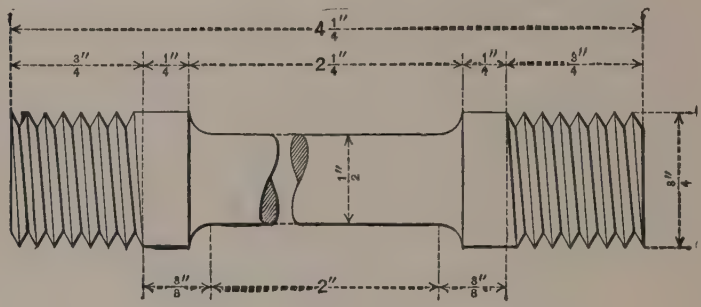

FIG. 2.

Finish. 10. The axles, either finished or plain, shall be straight and free from injurious seams, slivers, flaws, and other defects, and shall have a workmanlike finish.

V. MARKING.

Marking. 11. The name or brand of the manufacturer, date, melt number, and inspector's mark, shall be legibly stamped on each axle. Unless otherwise indicated, these marks shall be stamped at about the middle of the length of the axle.

VI. INSPECTION AND REJECTION.

Inspection. 12. (*a*) The inspector representing the purchaser shall have free entry, at all times while work on the contract of the purchaser is being performed, to all parts of the manufacturer's works which concern the manufacture of the material ordered. The manufacturer shall afford the inspector, free of cost, all

reasonable facilities to satisfy him that the axles are being furnished in accordance with these specifications. Tests and inspection at the place of manufacture shall be made prior to shipment.

(*b*) The purchaser may make the tests to govern the acceptance or rejection of material in his own laboratory or elsewhere. Such tests, however, shall be made at the expense of the purchaser.

(*c*) All tests and inspection shall be so conducted as not to interfere unnecessarily with the operation of the works.

13. (*a*) Axles which show injurious defects while being finished by the purchaser will be rejected, and the manufacturer shall be notified. **Rejection.**

(*b*) Unless otherwise arranged, any rejection based on tests made in accordance with Section 12(*b*) shall be reported within five working days from the receipt of samples.

14. Samples tested in accordance with Section 12(*b*), which represent rejected material, shall be preserved for two weeks from the date of the test report. In case of dissatisfaction with the results of the tests, the manufacturer may make claim for a rehearing within that time. **Rehearing.**

REPORT OF COMMITTEE A-2

ON

STANDARD SPECIFICATIONS FOR WROUGHT IRON.

Committee A-2 on Standard Specifications for Wrought Iron, was organized at Atlantic City, July 1, 1911. In October, 1911, the Executive Committee authorized the consolidation of Committee A-2 and Committee A-10, on Standard Specifications for Staybolt Iron, and at a meeting held in Philadelphia, November 14, 1911, a reorganization of the above committees was effected, with the election of Mr. S. V. Hunnings, as Chairman, and Mr. J. B. Young, as Secretary.

Subsequent to the Philadelphia meeting, four sub-divisions of the Committee were formed, as follows:

1. On Specifications for Iron Boiler Tubes and Iron Pipe.
2. On Specifications for Refined Wrought-iron Bars.
3. On Specifications for Staybolt, Engine-bolt, and Chain Iron.
4. On Specifications for Wrought-iron Plates and Shapes.

Owing to the limited time at their disposal, the various divisions did not attempt to cover all the lines of material allotted to them, but concentrated their efforts on one or two classes of material only, with a view to working on the others during the ensuing year. The Committee, therefore, offers for your consideration the following specifications:

1. For Staybolt Iron (Revised).
2. For Engine-bolt Iron.
3. For Refined Wrought-iron Bars.
4. For Iron Locomotive Boiler Tubes.

Staybolt Iron.—In view of the large percentage of 50,000-lb., 30-per cent-elongation iron that is used at the present time, the Committee considered the advisability of adopting specifications including two grades of iron, one grade the same as our present specifications and the other a 50,000-lb., 30-per cent-

elongation iron. After carefully considering the matter, however, it was felt that specifications including two grades of iron would result in confusion, and that it would be better to recommend specifications of a character that the consumers of the 48,000-lb., 28-per cent iron could adopt without material increase in cost, and that the consumers of the 50,000-lb., 30-per cent iron could adopt without feeling they were sacrificing quality. The Committee finally agreed upon the requirements of the proposed specifications. The strength, elongation, and reduction of area have been raised slightly over similar requirements in the present specifications, but the incorporation of a paragraph giving a retest of specimens breaking outside the middle third of the gage length and those developing defects in testing, largely offsets these higher requirements, as the manufacturer will not have to depend upon the "good nature" of the inspector for retests of such specimens and can, therefore, guarantee higher results.

The proposed revised specifications compare favorably with the requirements of the British Standard Specifications, and can be reasonably offered as a substitute for them and other similar foreign specifications.

The revised specifications include a new section covering an etch test to determine whether the process of manufacture described has been observed, and sections defining various terms embodied in the specifications.

The Committee did considerable work in the way of investigating the causes of irregularities in the results obtained from the vibration tests. There was not sufficient time to complete the investigation this year, but the work will be continued during the ensuing year, and the Committee feels confident of being able to standardize this test to the extent that the results will compare in accuracy with the tension test.

Engine-bolt Iron.—The specifications for engine-bolt iron are new. The physical requirements specified are those generally in use.

The process of manufacture prohibits the use of iron scrap or steel in the manufacture of this material; local mill crop-ends, however, are not considered scrap. The Committee felt that as this iron is used extensively for case-hardened and finished bolts, where the quality of the work depends largely upon the uni-

formity of the material, such material should be made exclusively from newly puddled iron.

These specifications include a section covering an etch test to determine whether the process of manufacture described has been observed.

Refined Wrought-iron Bars.—These specifications cover a grade of iron suitable for general forging, smithing and construction purposes. The Committee feels that the physical requirements and the bend and etch tests are of such a character that iron of a satisfactory quality for the above purposes will be insured.

The Committee desires to call attention to the fact that the specifications do not apply to the class of material sold by the mills to the jobbing trade as "merchant iron," since such iron is not sold by specification.

Iron Locomotive Boiler Tubes.—These specifications are practically a copy of the present Master Mechanics' specifications for Locomotive Boiler Tubes; the Committee, however, has reworded the clause covering allowances in gage, etc., as there has been frequent contention regarding the proper interpretation of the clause in the Master Mechanics' specifications.

During the ensuing year the Committee expects to take up the following questions:

1. Specifications for Chain Iron.
2. Specifications for Rivet Iron and Iron Rivets.
3. Specifications for Hammered-iron Sections.
4. Specifications for Plates and Shapes.
5. Refinement of the vibration test of the present Specifications for Staybolt Iron.

Respectfully submitted on behalf of the Committee,

J. B. YOUNG,
Secretary.

S. V. HUNNINGS,
Chairman.

NOTE.—The appendix to the report of Committee A-2 is not reprinted here. The action at the annual meeting, relative to the specifications in the appendix, is summarized following this report.—ED.

ACTION

ON

THE REPORT OF COMMITTEE A-2.

The four proposed standard specifications recommended by Committee A-2 were amended at the annual meeting and adopted in their amended form by letter ballot of the Society on June 1, 1912. The amendments to the specifications, as presented, are as follows:

Staybolt Iron.[1]

1. *Section 5.*—Omit Section 5 on "Vibration Tests.", as follows:

> "The test specimen shall stand a minimum of 6000 revolutions when subjected to the following vibration test:
>
> "The specimen, threaded with a standard V-thread, 12 threads to the inch, and held rigid at one end, shall have the other end moved in a circular path while stressed with a tensile load of 4000 lb. The circle described shall have a radius of $\frac{3}{32}$ in. at a point 8 in. from the fixed end of the specimen.",

and add the following explanatory footnote to the sub-heading, "II. Physical Properties and Tests.":

> "Committee A-2 on Standard Specifications for Wrought Iron, which prepared these specifications for presentation to the Society, desires to call attention to the fact that the vibration test has been omitted from the specifications. While recognizing its importance, the Committee feels that the variations in the results obtained by this test are so great that it is not advisable to include such a requirement in the specifications until it has been carefully standardized. The Committee means to institute further inquiries with the hope of reaching a sound basis for this test in the measurably near future."

[1] For these specifications in revised form see pages 261-263.

2. *Section 6* (now Section 5).—Omit the clause,

"in a solution composed of 50 per cent water, 25 per cent concentrated sulphuric acid, and 25 per cent concentrated hydrochloric acid.",

and add the following footnote to the marginal note, "Etch Tests.":

"A solution of two parts water, one part concentrated hydrochloric acid, and one part concentrated sulphuric acid is recommended for the etch test."

3. *Section 8* (now Section 7).—In the last line, change the words "Sections 5 and 6" to read "Section 5."

4. Add a new Section 10 under the sub-heading "Marking", as follows:

"The bars shall be stamped or marked as designated by the purchaser."

5. *Section 12 (b)*.—Change the clause,

"and returned to the manufacturer, who shall pay return freight.",

to read,

"and the manufacturer shall be notified."

ENGINE-BOLT IRON.[1]

1. *Section 6*.—Same as noted for Section 6, Staybolt Iron.

2. Add a new Section 11 under the sub-heading "Marking.", same as Section 10, Staybolt Iron.

3. *Section 12 (b)*.—Same as noted for Section 12 (*b*), Staybolt Iron.

REFINED WROUGHT-IRON BARS.[2]

Section 7.—Same as noted for Section 6, Staybolt Iron.

IRON BOILER TUBES.[3]

1. *Section 3*.—In the second line, omit the words "as seen in daylight" and substitute "(1200°–1400° F.)".

[1] For these specifications in revised form see pages 215-217.
[2] For these specifications in revised form see pages 218-221.
[3] For these specifications in revised form see pages 264-266.

After "heat" in the fourth line, insert "(600°–800° F.)".

After "tube" in the fourth line, insert the words "by pressure or".

2. *Section 4.*—In the last line, change "bending" to "opening."

3. *Section 6.*—Omit the clause,

> "in a solution composed of 50 per cent water, 25 per cent concentrated sulphuric acid, and 25 per cent concentrated hydrochloric acid, prepared by placing the water in a porcelain dish, adding the sulphuric acid and then the hydrochloric acid. The chemical action shall be allowed to continue",

and add the following footnote to the marginal heading "Etch Tests.":

> "A solution of two parts water, one part concentrated hydrochloric acid, and one part concentrated sulphuric acid is recommended for the etch test."

4. *Section 10* (now Section 11 (*a*)).—In the second line, change the words "shall not be less than 0.015 in. of the size ordered." to read, "shall not vary more than 0.015 in. from the size ordered."

5. *Section 14* (now Section 15).—Change the clause,

> "and returned to the manufacturer, who shall pay return freight.",

to read,

> "and the manufacturer shall be notified."

NOTE.—These specifications were further revised by Committee E-5 on Regulations Governing the Form but not the Substance of Specifications.—ED.

REPORT OF COMMITTEE A-6

ON

THE MAGNETIC TESTING OF IRON AND STEEL.

The Standard Magnetic Tests of Iron and Steel which were presented by the Committee and adopted at the last annual meeting have been carefully examined by a number of people. The result has been to show that they are in general satisfactory. However, difficulty has been experienced in the measurement of normal induction of sheet metal. The source of this trouble has been traced to the position of the compensating magnetizing coils.

The object in placing the compensating coils on the yoke strips was to permit the use of the same coils and magnetic circuit for the core-loss and normal-induction measurements, by having one pair of opposite solenoids constitute the main magnetizing coils, and the other pair the compensating coils.

However, it has developed that considerable trouble and some inaccuracy occurs unless extreme care is taken to make good magnetic joints.

If, on the other hand, the compensating coils are placed over the ends of the main solenoids, as they are in the method for testing rods, the difficulties of the measurement disappear. This latter arrangement has therefore the two arguments in its favor, that not only is it more practicable, but it also gives less difference between the methods of measurement of sheet metal and of rods.

The Committee therefore recommends that the Standard Magnetic Tests of Iron and Steel be amended so that, under the heading "Sheet Metal," lines 16 and 17, reading:

"The compensating coils shall consist of two solenoids surrounding the yoke strips,"

shall read:

"The compensating coils shall consist of four short coils,

each having the same number of turns wound closely over the ends of the magnetizing coils."

Respectfully submitted on behalf of the Committee,

C. W. BURROWS,
Chairman.

NOTE.—The above amendment, recommended by Committee A-6, was approved at the annual meeting and referred to letter ballot of the Society, which resulted favorably to its adoption. The Standard Magnetic Tests of Iron and Steel as thus amended appear on pages 210-214.—ED.

REPORT OF COMMITTEE B-1

ON

STANDARD SPECIFICATIONS FOR COPPER WIRE.

At the time the report of Committee B-1 was made at the last annual meeting, mention was made of the fact that it had been suggested that the Committee take under consideration the preparation of specifications for copper wire of other temper than standard hard-drawn wire, for which specifications had already been adopted.

The Committee has therefore held several meetings, and is now prepared to submit herewith proposed standard specifications for medium hard-drawn copper wire and for soft or annealed copper wire, which are appended to this report. The Committee unanimously recommends that these specifications be referred to letter ballot of the Society.

The Committee has no changes to recommend in the Standard Specifications for Hard-drawn Copper Wire.

With the approval of the Executive Committee of the Society, Committee B-1 is acting in conjunction with a committee from the American Electric Railway Engineering Association, with a view to having the two societies agree upon uniform specifications for copper trolley wire. One joint meeting has been held and work arranged for, to be discussed at a meeting to be held at a later date. There is good prospect of an agreement being reached which will permit the formulation of uniform requirements.

Respectfully submitted on behalf of the Committee,

J. A. CAPP,
Chairman.

NOTE.—The appendix to the report of Committee B-1 is not reprinted here. The action at the annual meeting, relative to the specifications in the appendix, is summarized following this report.—ED.

ACTION

ON

THE REPORT OF COMMITTEE B-1.

By action at the annual meeting the proposed specifications for (1) Medium Hard-drawn Copper Wire, and (2) Soft or Annealed Copper Wire, were referred to letter ballot of the Society, with the understanding that the numerical values for resistivity will be subject to modification when an agreement on an international standard has been reached by the International Electrotechnical Commission, and that Committee B-1 on Standard Specifications for Copper Wire and Committee B-2 on Non-Ferrous Metals and Alloys, will cooperate with a view of bringing about such an agreement.

At the annual meeting attention was called to the following errors in the proposed specifications for Soft or Annealed Copper Wire:

Errata.—In Table I, fifth line, first column, the figures "0.101 to 0.093" should read "0.101 to 0.083;" in the sixth line, first column, the figures "0.092 to 0.081" should read "0.082 to 0.081."

In Table I, third column, under "Minimum Package Weights," the figures should be raised to line with those in the second column.

The letter ballot on the above specifications, canvassed on June 1, 1912, resulted favorably and these specifications appear on pages 277-291.—Ed.

REPORT OF COMMITTEE C-1

ON

STANDARD SPECIFICATIONS FOR CEMENT.

Committee C-1 during the past year has given consideration to the subject of standard specifications for cement, but at this time is not prepared to recommend any changes in the specifications already adopted by the Society.

As the members of the Society will remember, the function of this Committee was to specify requirements which cement must fulfill. A similar committee of the American Society of Civil Engineers, originally appointed in 1897, had for its object, recommendations as to uniform-method tests of cement without, however, specifying the actual requirements. Members of this special committee of the American Society of Civil Engineers, who were members of this Society, were added to Committee C-1 soon after its formation.

The special committee of the American Society of Civil Engineers presented its report, which was accepted by the Society at the annual meeting on June 18, 1911. Owing to the fact, however, that it was understood that the United States Engineer Corps was considering a revision of its specifications, the committee was continued another year and was instructed to present its final report at the annual meeting January 17, 1912. A copy of this report is appended hereto. During the summer, a Board representing the United States Engineer Corps considered the revision of the specifications of that Corps, and on November 27, 1911, a meeting was held in Philadelphia at which were present representatives of the special committee of the American Society of Civil Engineers, of Committee C-1, and of the Departmental Committee. This latter committee, composed of representatives of all the Government Bureaus, was created during the summer for the purpose of unifying the specifications for cement for use by the various branches in the United States Government.

On January 8, 1912, representatives of Committee C-1

also attended a similar joint conference in Washington, called by the Board of Engineer Officials.

The result of these meetings has been a nearer approach to the unification of all the specifications. There are some points, however, on which agreement has not been reached. At a meeting of Committee C-1 held on March 7, 1912, the following resolution was adopted:

> *Resolved:* In order to secure uniformity in specifications for cement, it is recommended that the Board of Direction of the American Society of Civil Engineers, the Committee on Standard Specifications for Cement of the American Society for Testing Materials, and the Government Departmental Committee on the Specifications for Cement, be each requested to appoint a committee of three to confer for the purpose of reconciling differences.

It is understood that these committees will be appointed and that joint conferences will be held for the purpose indicated in the above resolution.

It is a matter of congratulation that the specifications for cement in this country, so far as essential points are concerned, are in substantial agreement with the specifications adopted by this Society. A cement which would pass the specifications of this Society would probably pass the Government specifications, and vice versa.

Respectfully submitted on behalf of the Committee,

G. F. SWAIN,
Chairman.

RICHARD L. HUMPHREY,
Secretary.

APPENDIX.

FINAL REPORT OF THE SPECIAL COMMITTEE OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS ON UNIFORM TESTS OF CEMENT.[1]

THE PRESIDENT AND MEMBERS, AMERICAN SOCIETY OF CIVIL ENGINEERS.

GENTLEMEN:—At the Annual Meeting, held January 18, 1911, your Committee on Uniform Tests of Cement submitted a final report, as required by resolution passed at the preceding Annual Meeting, and stated that it seemed possible, by conference with a Board of Engineers to be appointed by the Chief of Engineers of the United States Army, to agree upon methods approved by both the Board and your Committee, which it was believed would result in uniform practice by all engineers in the United States; the Society thereupon continued the Committee for one year.

The Army Board was duly appointed, its membership including one of the members of your Committee. Conferences were held or hearings given as follows:

On September 12, 1911, a hearing was given by the Army Board in New York, attended by representatives of your Committee, by a representative of one of the commercial testing laboratories, by a representative from the United States Bureau of Standards, and by several manufacturers. It appeared at this hearing that a tentative specification for methods of testing had been prepared by representatives of several bureaus in Washington, adopting the methods recommended in previous reports of your Committee, except in regard to the determination of normal consistency and time of setting of cement pastes. Upon the request of your Committee two additional conferences were held, one on November 27, 1911, the other on January 8, 1912, with the hope on the part of your Committee of reaching entire agreement, but without favorable result.

In submitting this, its final report, your Committee desires to describe, in some detail, the differences between the proposed methods of making these tests, and to state on these points the reasons for its final recommendations, and to refer to the current practice in this and other countries.

The Vicat apparatus, which is recommended by your Committee for the determination of consistency and time of setting, was originally devised by Vicat about 1818, to ascertain the relative rates of induration of mortars, and although it has since been slightly modified to make it more suitable for determining the time of setting of plastic mortars of neat cement, the principle of the apparatus, the vertical guiding of a weighted wire, remains unchanged. The ball method for determining normal consistency, which has

[1] Presented to the Annual Meeting, January 17, 1912.

been adopted by the Army Board, is not new, but was used in France before the adoption of the Vicat apparatus for this purpose. The relative merits of the two methods were investigated, with many comparative experiments, by a Commission on Methods of Testing Materials of Construction appointed by the Government of France in 1891. As a result of this investigation, the Commission in 1893 adopted the Vicat apparatus for determining normal consistency; it has since been adopted by the International Association for Testing Materials, and in many countries, as will be shown further on in this report.

The so-called Gillmore wires appear to have been first proposed by M. Antoine Racourt, to whom Gen. Joseph G. Totten, Honorable Member American Society of Civil Engineers, refers in his translation of "Essays on Hydraulic and Common Mortars, etc.," by Treussart and others, published in 1842. Gen. Q. A. Gillmore, Member American Society of Civil Engineers, in his "Practical Treatise on Limes, Hydraulic Cements, and Mortars," refers to these wires as having been used by Gen. Totten prior to 1830, and recommends their use for determining time of setting; it does not appear that they have ever been used for determining normal consistency, for which purpose they are not suitable.

When your Committee began the duty assigned to it, it took into consideration the ball method and the Vicat apparatus for testing consistency. A great many tests were made by the members of the Committee to determine the relative value of these methods, after which the method by use of the Vicat apparatus was formulated, and the Committee proceeded to test it in comparison with other methods in common use. The tests were arranged to include a comparison, of the method of mixing pastes and mortars and molding test pieces recommended by the Committee, with other methods. Accordingly a meeting was held at the laboratory of the Atlantic Avenue Improvement of the Long Island Railroad, under the direction of your Committee, and in the presence of several of its members, at which were present representatives of seven laboratories of recognized standing. The cement was prepared carefully by mixing with a garden rake on a clean papered floor; then sifting in long thin layers one on top of the other and again mixing with the rake and sifting into a barrel from which it was used. The operators were all experienced in testing cement, and, with a single exception, were accustomed to daily practice; those who took part assembled in an outer room, from which each in turn entered the laboratory where he made determinations for consistency and also made a set of twenty briquettes, all in accordance with the Committee's methods, and at the same time made a set of ten briquettes in accordance with his own method. For the purpose of uniformity, the weighing of the cement and measuring of the water was done by one person while the manipulation of the Vicat apparatus was entrusted to another. After completion of his work each operator remained in the laboratory, affording no opportunity for exchange of views with those who had not performed the experiments. The briquettes were all kept under the same conditions, stored in moist air for twenty-four hours, and then immersed in water and kept at a temperature as near 70° F. as possible, and after a specified period were re-

moved from the water, the excess moisture absorbed by blotting paper, the briquettes weighed and broken. The result of these tests showed that the several operators agreed as to the proper percentage of water required for normal consistency determined by the Vicat apparatus. In making briquettes by their own methods the operators used different consistencies, from wet paste to material so dry that it required pounding in the mold with a mallet, the percentage of water varying from sixteen to twenty-four per cent; more consistent results were obtained with the Committee's consistency and by the methods recommended by the Committee than with the methods of the operators.

Arrangements were then made for another series of experiments with five samples of Portland cement and four samples of natural cement, carefully prepared as before described, hermetically sealed in tin cans and sent to some twenty-six testing laboratories in various parts of the country with a request to test the cements on a given date in accordance with the methods formulated by your Committee, and to report the results to the Secretary on certain dates. These results were collated and a study showed such agreement in regard to consistency, strength, and other tests as to satisfy the Committee that by its methods concordant results could be secured by different operators in different parts of the country. In order to compare the ball test for normal consistency with the Vicat apparatus method, samples of cement were prepared and sent out to several members of the Committee; simultaneous tests of the two methods were made, and the results were conclusive, the Vicat apparatus giving more concordant results than the ball method. The Committee does not wish it to be inferred that any method yet proposed for determining consistency will always prove exact, for no such method has been devised, but it does fully believe that, by the method recommended, operators in different parts of the country can secure more concordant results than can be obtained by any other method yet proposed.

The Army Board has adopted the ball test, which was recently defined as follows:

"A quantity of cement paste should be mixed in the manner hereinafter described under Tensile Tests and quickly formed into a ball about 2 in. in diameter. The ball should then be dropped upon a hard, smooth surface from a height of 2 ft. The paste is of normal consistency when the ball does not crack and does not flatten more than one-half of its original diameter."

The ball test in some form has been in use for many years as a rough and ready means of judging the consistency of mortar. Quite recently a number of experiments with the test were made under the direction of the Committee by experts in testing cement, with the result that variations in the percentage of water amounting to two or three per cent of the weight of the cement, or about ten to fifteen per cent of the weight of the water, might not be detected by this test of consistency.

The method of forming the ball can hardly be defined so that the work put on the paste by different operators in shaping it will be the same; if the ball is oblong, rather than spherical, the amount of flattening will depend

considerably on whether the ball is dropped with the longer or shorter axis vertical. The specification above quoted may be made much more definite in this respect, and the amount of flattening can be better defined; such changes may have been made in the more recent revisions by the Army Board, but even with this assumed your Committee is convinced that the test it recommends is the better; it requires less time for the preparation of the sample of paste, but, on the other hand, the application of the cylinder requires more time than dropping the ball, and the complete test with the Vicat apparatus may require a little more time than the ball test. The difference, however, is not important, since either test is quickly made, and the cost is trifling.

The percentage of water adopted by the Army Board for mortars containing one part of cement to three parts of Ottawa sand is uniformly one per cent greater than recommended by your Committee. Additional experiments made recently by your Committee, confirm its previous recommendation.

In the tests for time of setting it is sought to determine two stages in the process, one when the paste ceases to be plastic, termed the "initial set," the other when it will support a given weight on a given area, termed the "final set." Neither term is absolutely correct, particularly the term "final set;" each as used depends largely on the instrument for making the test, but with this stated and its application carefully described and followed the terms become readily understood.

Your Committee recommends the use of the Vicat needle for determining these stages, while the Board of Army Engineers adopts the Gillmore needles. It is believed that the phrase, "Vicat needle apparatus" has given the incorrect impression of complexity. The apparatus consists simply of a single rod of given weight and given diameters at the ends, moving vertically in a guide; in its use, the end of the rod is brought into contact with the paste and held lightly by a thumb-screw, then released with a minimum vibration or jarring. The Gillmore needles are wires of given diameters carrying given weights; two are required for determination of time of setting; they are applied by hand, without guides, and the results depend much on the steadiness of hand and the skill of the operator. It seems to your Committee that there should be no doubt that the Vicat needle is the better instrument; although slightly more expensive, it does not increase the cost of a laboratory equipment more than three or four per cent.

Of the two stages in the process of setting, the initial set is of the greater importance, since it marks the moment when the setting becomes appreciable, and it is generally believed that if the paste is broken up after this stage is reached its final strength will be reduced. In the method recommended by your Committee the sample for testing is formed from the paste with a minimum of manipulation; care is taken not to compress the paste, and the surface to which the needle is to be applied is formed by slicing off the paste above a given thickness of sample without pressure upon the sample, the condition of the paste at the surface being indentical with that in the mass. The thickness of the mass is a little more than $1\frac{1}{2}$ in. and is a definite quantity. When the sample is first formed, the Vicat needle penetrates readily through

the entire thickness or depth of the mass; as the setting proceeds, a moment arrives when the needle no longer penetrates entirely through, but stops when within a short, specified distance from the lower surface. This is taken as the initial set. For such a test it is obvious that the movement of the needle must be guided, for unsteadiness in its lateral support would have a great influence on the amount of penetration. For the application of the Gillmore needle, a thin pat (about $\frac{1}{2}$ in. thick) is formed on a glass plate by troweling. The amount of troweling does not admit of clear definition, and will vary widely with different operators. It is a matter of common observation that a troweled surface differs much in density from the mass, and in the pats for the Gillmore needles this difference will be highly variable because of the difference in troweling. This is important, since the initial set is determined with the Gillmore needle not by penetration of the mass, but by a slight indentation of its surface; thus depending, not only on the chemical action of setting, but on the variable physical preparation of the surface, as well as on the variable condition of the atmosphere, which will affect a surface more than a mass.

It has been stated that the Gillmore needle test requires less time. There can be no question that the Vicat sample for testing is more quickly formed than the Gillmore pat, while a single application of the Gillmore needle will require less time than the Vicat needle; if a single test were made at the specified limit of time, to determine simply whether the initial set had occurred, the Vicat test would be the quicker; if repeated applications of the needle were made to ascertain at what moment the set occurred and the number of applications were large, the Vicat method might require more time. The difference would be small if the Gillmore needle were used with great care, and would not be important in any case.

In the judgment of your Committee the determination of initial set is of much importance, and is much better done with the Vicat needle used in the manner it recommends; in the determination of normal consistency, however, the superiority of the Vicat method over the ball method, while appreciable, is less marked.

The determination of final set is of less importance than the determination of initial set; in both methods the test is of indentation, not penetration, the difference being mainly in the nature of the surface tested. For reasons already given, the surface of the sample used with the Vicat needle represents the mass more fairly than the troweled surface of the pat used with the Gillmore needle.

Your Committee in its endeavor to reach an agreement with the Army Board offered to accept the less desirable ball method for determining normal consistency if the Board would adopt the Vicat needle for time of setting. By the rejection of this offer, your Committee was brought to the question whether, for the sake of complete agreement with the Army Board, substantial agreement having already been reached, it would recommend for the test of time of setting a method which it believed to be greatly inferior in regard to an important test, constituting a decided retrogression in methods

for testing cement.[1] The methods of the Army Board have the concurrence of a departmental committee representing several branches of the United States Government, and your Committee, having asked at the last Annual Meeting for an extension of time in order to secure uniformity in methods, felt strongly the desirability of effecting entire agreement, and has given the questions of difference renewed and most earnest consideration.

The Vicat apparatus recommended by your Committee in its first preliminary report in 1903, had been in use for many years in many laboratories and had been thoroughly tried out in the laboratory of the City of Philadelphia. Since 1903 its use has been greatly extended. Previous to the last Annual Meeting, the Secretary of this Committee addressed a letter of inquiry to testing laboratories in the United States, and received replies from 143; of these, 93 reported the use of the methods recommended by your Committee, and 72 reported them very satisfactory; 12 were from Army Engineers who used the methods prescribed by the Engineer Corps in Professional Paper 28; 30 used their own methods, and 8 reported that they did not make cement tests; of the total number of replies, 19 used the Gillmore needles and 114 used the Vicat apparatus; 2 used their own methods, and the remainder, as previously stated, did not make cement tests.

The method recommended by your Committee being thus supported in this country, the practice in foreign countries was investigated, with the following results:

SUMMARY OF METHODS SPECIFIED FOR DETERMINING TIME OF SETTING AND NORMAL CONSISTENCY IN FOREIGN COUNTRIES.

Country	Time of Setting	Normal Consistency
Belgium[2]	Vicat Needle.	Vicat Apparatus.
Denmark[3]	" "	" "
France[2]	" "	" "
Holland[4]	" "	" "
Hungary[5]	" "	" "
Italy[2]	" "	" "
International Assn. Test. Materials	" "	" "
Russia[6]	" "	" "
Austria[5]	" "	Boehme Hammer Apparatus.
Germany[2]	" "	" " "
Switzerland[7]	" "	" " "
England[8]	" "	Note 1.
Canada[9]	Note 2.	Note 3.

[1] One member of the Committee has expressed dissent from this statement of the case, and believes that from a practical point of view the results obtained by the ball method for determining normal consistency and the Gillmore needles for time of setting are as satisfactory as those given by the Vicat apparatus.

[2] Ministry of Public Works.
[3] Danish States Testing Laboratory.
[4] Royal Institute of Engineers.
[5] Association of Engineers and Architects.
[6] Ministry of Ways and Communications.
[7] Ministerial Regulations.
[8] Engineering Standards Committee.
[9] Canadian Society of Civil Engineers.

NOTE 1.—The cement shall be mixed with such proportion of water that the mixture shall be plastic when filled into the Vicat mold. The gaging shall be completed before the signs of setting occur.

NOTE 2.—The cement shall be considered as having taken "initial set" when a wire $\frac{1}{12}$ in. in diameter, loaded to weigh $\frac{1}{4}$ lb., shall leave a distinct mark on the pat, but not appreciably penetrate the surface, and the "final" or "hard set" when a wire $\frac{1}{24}$ in. in diameter, loaded to weigh 1 lb., shall leave a distinct mark, but not appreciably penetrate the surface.

NOTE 3.—For a cement 75 per cent of which will pass a No. 200 sieve, a maximum of 22 per cent of water, and an additional 1 per cent of water for each extra 5 per cent of cement that will pass the No. 200 sieve.

Your Committee would direct attention to the Report of The Engineering Standards Committee of England, supported by:

The Institution of Civil Engineers,
The Institution of Mechanical Engineers,
The Institution of Naval Architects,
The Iron and Steel Institute,
The Institution of Electrical Engineers,

dated August, 1910, containing a revision of the British Standard Specifications for Portland Cement, in which the following statement is to be found concerning the determination of the time of setting:

"Since the issue of the first revision of the Specification the Committee has continued its investigation into the question of the determination of the initial setting time of cement. It was found that while the final setting times determined by the British Standard and Vicat needles approximated very closely, the initial setting time as determined by the British Standard needle differed considerably from that given by the Vicat needle which is in general use, and also from that obtained by the rough and ready test of the finger nail.

"It was considered preferable that one instrument only should be specified for determining the initial and final setting times of cement, and the Vicat needle has been adopted for that purpose."

By this action a modified form of the Gillmore needle was superseded.

At the Sixth International Congress for Testing Materials, held at Copenhagen in 1909, an official report on the progress in methods of testing hydraulic cements was presented by R. Feret, Ingénieur en Chef, Laboratoire d'Essai des Ponts et Chaussées, at Boulogne sur Mer. In this report M. Feret makes the following comments on methods for determining the duration of setting:

"The use of the Vicat needle continues to be the only practical method in use for the determination of the duration of the period of setting of hydraulic cements. The appliance is one of extreme simplicity, but its readings are sometimes uncertain, especially when it is a question of determining the end of the period; besides the readings are of a purely conventional character and do not appear always to bear a sufficiently constant relation to the duration of the setting period of the mortars of actual practice.

"The discovery of more exact methods has therefore been attempted."

Attention is further called to a paper by W. C. Reibling and F. D. Reyes,

on "The Setting Properties of Portland Cement," contained in Vol. VI, No. 3, Section A, June, 1911, of the *Philippine Journal of Science*, published by the Bureau of Science of the Philippine Government, in which the authors make the following comments on the Vicat apparatus:

"Throughout our work, several standard methods were employed for determining the time of the initial and final set. The method employing the Vicat needle as adopted by the American Society for Testing Materials was found to be the most consistent with the manner in which the cement is used in actual work. It is reliable, impartial and accurate."

In view of all this evidence, the Committee does not feel justified in modifying its previous recommendation of the Vicat apparatus.

The methods recommended by your Committee imply the use of well-equipped laboratories, such as are now usually found in connection with large works of construction, and it is believed they are described in sufficient detail to enable skilled operators to obtain concordant results without communicating with one another. This is shown by comparing past and present practice in regard to normal consistency. When your Committee began its work, the consistency adopted in the different laboratories had a wide range, from very soft to very dry paste; now the practice is virtually uniform in the United States, and this is due, the Committee firmly believes, to the general use of the methods recommended by it in previous reports, or, in other words, to training with the Vicat apparatus.

Where the construction work is of small extent, field tests of less definite character will be made, depending on the facilities and time available. These are so variable in extent and kind, and can be so readily specified by the engineer, that it has not been deemed advisable or practicable to enumerate and describe them.

Since its last report your Committee has made several verbal changes in its recommendations. Methods for igniting cement and for determining insoluble residue have been inserted, although it is apprehended that the latter determination may prove to be of little value. The Committee now recommends the clip with roller points, which has been used successfully and by which central breaks may be obtained in most cases. The final recommendations are submitted herewith.[1] As in former reports, the significance of each test is stated, as well as the method of carrying it out.

For the convenience of engineers who may desire to incorporate in their specifications the methods recommended, a condensed draft is also submitted,[2] in which discussion is omitted.

In accordance with the resolution passed at the last Annual Meeting, the duty of this Committee is concluded with this report.

Respectfully submitted on behalf of the Committee,

GEORGE S. WEBSTER, *Chairman.*
RICHARD L. HUMPHREY, *Secretary.*

JANUARY 17, 1912.

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[1] See page 306.
[2] See page 320.

REPORT OF COMMITTEE C-6

ON

STANDARD TESTS AND SPECIFICATIONS FOR DRAIN TILE.

This Committee held its organization meeting at Chicago, September 28 and 29, 1911. The meeting was very well attended. The following permanent organization was effected:

Chairman, A. Marston, Ames, Iowa; Vice-Chairman, A. N. Talbot, Urbana, Ill.; Secretary, J. T. Stewart, University Farm, St. Paul, Minn.

For the purpose of carrying out the investigations necessary before formulating specifications the following sub-committees were established:

I. On Tests.
II. On Data of Manufacture of Clay Tile.
III. On Data of Manufacture of Cement Tile.
IV. On Durability of Tile.
V. On Construction and Field Specifications.

Each of the sub-committees has outlined certain work, and Sub-Committee I on Tests, in particular, has planned quite extensive comparative tests of strength by different methods, in order to determine the data necessary for the selection of a standard method of testing.

Certain members of the Committee later urged that the large amount of cracked tile now being found in large tile drains recently constructed in the Middle West at a cost of hundreds of thousands of dollars has created an emergency need for some immediate standards of strength, for use during the present season, and the question of the wisdom of adopting tentative standard specifications for immediate use was submitted to the members of the Committee by letter in February, 1912. After careful consideration, it was decided that their adoption would be inadvisable.

It is planned to push the investigation and other work of the various sub-committees as actively as possible during the coming year.

Respectfully submitted on behalf of the Committee,

A. Marston,
Chairman.

J. T. Stewart,
Secretary.

REPORT OF COMMITTEE D-4

ON

STANDARD TESTS FOR ROAD MATERIALS.

Committee D-4 recommends for adoption the following definitions of terms, with the understanding that they are intended to apply to materials of interest in road and paving work. In the opinion of the Committee the definitions given in dictionaries and encyclopædias are misleading and in many cases obsolete, and at variance with customary usage in the art and science of highway engineering. The presentation of the following definitions is the first step in the establishment of a standard nomenclature:

Bitumens are mixtures of native or pyrogenous hydrocarbons and their non-metallic derivatives, which may be gases, liquids, viscous liquids, or solids, and which are soluble in carbon disulphide.

Bituminous, containing bitumen or constituting the source of bitumen.

Dead oils are oils with a density greater than water which are distilled from tars.

Fixed carbon is the organic matter of the residual coke obtained upon burning hydrocarbon products in a covered vessel in the absence of free oxygen.

Free carbon in tars is organic matter which is insoluble in carbon disulphide.

Respectfully submitted on behalf of the Committee,

L. W. PAGE,
Chairman.

PRÉVOST HUBBARD,
Secretary.

[NOTE.—The proposed definitions presented in this report were adopted by letter ballot of the Society on August 5, 1912, and appear on page 362.—ED.]

APPENDIX.

MINORITY REPORT OF COMMITTEE D-4

ON

STANDARD TESTS FOR ROAD MATERIALS.

The undersigned as a member of Committee D-4, not being in accord with the report presented by the majority of the Committee on definitions of certain terms used in connection with highway construction, begs leave to present the following as a minority report:

In the writer's opinion, the definitions presented are unsatisfactory, both in matter and form, and in one instance is quite contrary to the etymological significance of the word defined. The majority report defines bitumen as a "mixture of native or pyrogenous hydrocarbons and their non-metallic derivatives, etc." The Committee throws over all authorities that have heretofore ruled on the subject, and provides that by its arbitrary decision coal tar is a bitumen. It is stated by the Committee that it believes the definitions of the dictionaries and encyclopædias are unsatisfactory, and brushes aside the following definitions of our best known dictionaries and writers:

"Bitumen: The name given by Latin writers, especially by Pliny, to various forms of hydrocarbons now included under the names asphaltum, meltha and petroleum." Century Dictionary, Edw. S. Dana, Ph.D.

"In modern scientific use, the generic name of certain mineral inflammable substances, native hydrocarbons more or less oxygenated, liquid, semi-liquid, and solid, including naphtha, petroleum, asphalt etc."
New English Dictionary, Murray.

"Any native mixture of hydrocarbons, oxygenated, as naphtha and especially asphalt." Standard Dictionary.

"By extension, any one of the natural hydrocarbons, including the hard, solid, brittle varieties called asphalt, the semi-solid maltha and mineral tars, the oily petroleums, and even the light, volatile naphthas."
Webster's Dictionary.

"This term includes a considerable number of inflammable mineral substances consisting mainly of hydrocarbons. They are of various consistence, from thin fluid to solid, but the solid bitumens are for the most part liquefiable at a moderate heat. The purest kind of fluid bitumen called naphtha

or rock oil, is a colorless liquid of specific gravity 0.7 to 0.84 and with a bituminous odor. It often occurs in nature with asphalt and other solid bitumens. Petroleum is a dark-colored fluid variety containing much naphtha. Maltha or mineral tar is a more viscid variety. The solid bitumens are asphalt (q. v.) mineral tallow or hatchetin; elastic bitumen, mineral caoutchouc or elaterite; ozokerite." Dictionary of Applied Chemistry, Thorpe.

"A generic name for a variety of substances found in the earth, or exuding from it upon the surface, in the form of springs. The liquid varieties become inspissated by exposure and eventually harden into the solid form, which is asphaltum." Appleton's American Cyclopædia.

"Bitumen is the name used to denote a group of mineral substances, composed of different hydrocarbons, found widely diffused throughout the world in a variety of forms which grade from thin volatile liquids, to thick semi-fluids and solids, sometimes in a free or pure state, but more frequently intermixed with or saturating different kinds of inorganic matter."
From "Highway Construction" by Austin T. Byrne.

"The word bitumen may, therefore, be strictly defined as a general term that is used to designate a class of minerals as they occur in nature, that are soluble in chloroform and other neutral liquids." S. F. Peckham.

"Any mixture of hydrocarbons and their derivatives of mineral occurrence, whether solid, liquid or gaseous, which is soluble in chloroform or similar solvents." George W. Tillson.

It seems to me that this is a most arbitrary procedure. If the definition in Thorpe's Dictionary of Applied Chemistry cannot be accepted as a satisfactory one for bitumen, the entire structure of chemical nomenclature might be overthrown.

As a substitute for the definition proposed by the majority of the Committee, I would suggest the following:

Bitumen is a material found in nature, consisting of a mixture of hydrocarbons and their derivatives, which may be a gas, liquid, a viscous liquid or maltha or a solid but, if solid, melting more or less readily on the application of heat and soluble in carbon disulphide or similar solvents.

The definition of "bituminous" is equally unsatisfactory from the writer's point of view, being defective in so far as it is based on the previous definition of bitumen. The writer would suggest the following:

A material is said to be bituminous when it contains bitumen or material resembling bitumen, or if it yields bituminous material, or if it constitutes the source of bituminous material. Coal-tar is called a bituminous material

from its resemblance physically to some of the denser forms of the native bitumen, although it contains no bitumen. Bituminous macadam is a road surface bound with bitumen or bituminous material.

The definition of "dead oils," in the writer's opinion, is not exact. Dead oils are only obtained from coal-tar, and I believe the Committee's definition should be modified to read "distilled from coal-tar." The oils from water gas and other tars are not properly designated dead oil.

The definition of "fixed carbon" should, the writer believes, be modified to include the method by which it is obtained. He believes that the definition should read:

Fixed carbon; the ash-free residual coke obtained by the ignition of bitumen or bituminous material, according to the method recommended by the Committee on Coal Analysis of the American Chemical Society, published in the journal of the Society for 1889, Vol. 21, page 1116.

Or it might read:

A term originally applied to the residual left on the ignition of bituminous coal in a covered crucible, and calculated to an ash-free condition, under definite and arbitrary conditions arrived at by common agreement; now adopted to describe the ash-free residual left on the ignition of a native bitumen under the same conditions.

The writer believes the following definition of "free carbon" is preferable to that proposed by the Committee:

Free carbon is that portion of a tar or residual pitch which is quite inert and insoluble in carbon disulphide and other similar solvents.

It may not necessarily be organic matter, as defined by the Committee, but may contain also certain mineral constituents which are insoluble in the solvent mentioned.

As a whole the definitions proposed by the majority of the Committee seem to the writer, in view of his twenty-five years' experience with the literature of the subject, to be extremely unsatisfactory, and he believes that they would not be creditable to the Society if adopted by letter ballot.

Respectfully submitted,

CLIFFORD RICHARDSON

REPORT OF COMMITTEE D-6

ON

STANDARD SPECIFICATIONS FOR COKE.

A meeting of this Committee was held at the Engineers' Club, New York, on the afternoon of the 27th inst.

After a full discussion, it was the sense of the meeting that conditions are at present such as to prevent the formulation of definite standard specifications for bee-hive and by-product coke, covering any wide scope.

The first step toward the development of standard coke specifications is to formulate definite methods for the sampling, chemical analysis, and physical testing of coke. The Committee has undertaken this work, and has appointed a sub-committee to report from time to time on the existing methods of sampling coke and on the physical testing of coke, and to recommend standard methods, based thereon.

In order to decide on standard methods for the chemical analysis of coke, the sub-committee will confer with the Committees of the American Chemical Society, and the American Foundrymen's Association, now already engaged in the standardization of the methods for the analysis of coke.

The Secretary of Committee D-6 was instructed to assist the sub-committee by collecting data on the methods now in use in the United States for the physical testing of coke, including the shatter, abrasion, porosity, cell structure and specific gravity tests.

Committee D-6 will report the results of the work above outlined at the next annual meeting of the Society.

C. H. ZEHNDER,
Chairman.

ALBERT LADD COLBY,
Secretary.

REPORT OF COMMITTEE E-5

ON

REGULATIONS GOVERNING THE FORM BUT NOT THE SUBSTANCE OF SPECIFICATIONS.

In pursuance of a resolution adopted at the last annual meeting of the Society, the Executive Committee authorized the creation of a committee to be known as Committee E-5 on Regulations Governing the Form but not the Substance of Specifications, consisting of one representative from each of the standing technical committees concerned with specifications for materials, methods of tests, or other methods which it may be desired to standardize, and the Secretary-Treasurer of the Society, *ex-officio*. That Committee has held two meetings and begs to report the adoption of the Regulations appended to this report.[1]

Inasmuch as the personnel of Committee E-5 is thoroughly representative of the standing technical committees concerned with specifications and methods, the Committee recommended to the Executive Committee of the Society that the responsibility for the general Regulations Governing Technical Committees (see 1911 Year-book, pages 323–325) shall also be vested hereafter in Committee E-5. The Executive Committee has authorized this arrangement with the understanding, (1) that proposed changes in these Regulations originating with Committee E-5 shall be subject to approval by the Executive Committee of the Society; and (2) that the Executive Committee of the Society shall make no changes in these Regulations without first referring the same to Committee E-5.

Committee E-5 has adopted the following regulations for its own government:

1. By action of the Executive Committee of the Society,

[1] The Regulations originally appended to this report appear on pages 105–113.—Ed.

the Committee shall consist of one representative from each of the standing technical committees concerned with specifications for materials, methods of tests, or other methods which it may be desired to standardize, and the Secretary-Treasurer of the Society, *ex-officio*.

2. The administrative work of the Committee shall be vested in an Executive Committee consisting of the Chairman, Vice-Chairman, and five additional members.

3. The Regulations Governing the Form but not the Substance of Specifications shall be printed annually in the Year-book for the guidance of the technical committees.

4. The individual members of Committee E-5 shall be invited yearly to submit by letter suggestions for the modification or extension of these Regulations. These suggestions shall be transmitted to the Executive Committee of Committee E-5, which is authorized to pursue one of the following courses:

(*a*) To submit these suggestions to letter ballot of the Committee at large with favorable or unfavorable recommendations.

(*b*) To call a meeting of the Committee for the consideration of these suggestions.

5. On the recommendation of Committee E-5, the Executive Committee of the Society has decided to hold Committee E-5 responsible for the general Regulations Governing Technical Committees (see 1911 Year-book, pages 323–325), with the understanding, (1) that proposed changes in these Regulations originating with Committee E-5 shall be subject to approval by the Executive Committee of the Society; and (2) that the Executive Committee of the Society shall make no changes in these Regulations without first referring the same to Committee E-5.

6. With respect to the general Regulations referred to in Paragraph 5, the procedure defined in Paragraphs 3 and 4 shall be observed.

7. The Secretary of the Society shall be given full authority in the enforcement of the Regulations Governing the Form but not the Substance of Specifications and shall be personally responsible for the results.

In so far as practicable the regulations embodied in the Appendix[1] to this report will be observed in connection with specifications to be presented at this annual meeting, and it is recommended that the Secretary of the Society be authorized to apply these regulations to any specifications after their adoption by letter ballot of the Society and before such specifications are printed in the 1912 Year-book.

Respectfully submitted on behalf of the Committee,

EDGAR MARBURG,
Chairman.

[1] The Regulations originally appended to this report appear on pages 105-113.—ED.

AMERICAN SOCIETY
FOR
TESTING MATERIALS.

AFFILIATED WITH THE
INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.

YEAR-BOOK
1912

CONTAINING THE

STANDARD SPECIFICATIONS

AND

List of Members and Technical Committees, and other Information concerning the American Society for Testing Materials and the International Association for Testing Materials.

EDITED BY THE SECRETARY,
UNDER THE DIRECTION OF THE COMMITTEE ON PUBLICATIONS.

OFFICE OF THE SECRETARY, UNIVERSITY OF PENNSYLVANIA, PHILADELPHIA, PA.

PUBLISHED BY THE SOCIETY.

1912.

CHARTER

OF THE

AMERICAN SOCIETY FOR TESTING MATERIALS.

To the Honorable the Judges of the Court of Common Pleas No. 2 in and for the City and County of Philadelphia: of March Term, 1902, No. 2056:

In compliance with the requirements of an Act of the General Assembly of the Commonwealth of Pennsylvania, entitled "An Act to Provide for the Incorporation and Regulation of Certain Corporations," approved the 29th day of April, A.D. one thousand eight hundred and seventy-four, and the supplements thereto, the undersigned, Henry M. Howe, Charles B. Dudley, Edgar Marburg, Robert W. Lesley, Mansfield Merriman, Albert Ladd Colby and William R. Webster, six of whom are citizens of Pennsylvania, having associated themselves together for the purposes hereinafter set forth, and desiring that they may be incorporated according to law, do hereby certify:

1. The name of the proposed corporation is the "AMERICAN SOCIETY FOR TESTING MATERIALS."

2. The corporation is formed for the Promotion of Knowledge of the Materials of Engineering, and the Standardization of Specifications and the Methods of Testing.

3. The business of the said corporation is to be transacted in Philadelphia.

4. The said corporation is to exist perpetually.

5. The names and residences of the incorporators are as follows:

HENRY M. HOWE, 27 West Seventy-third Street, New York.
CHARLES B. DUDLEY, Altoona, Pa.
EDGAR MARBURG, 517 South Forty-first Street, Philadelphia.
ROBERT W. LESLEY, 22 South Fifteenth Street, Philadelphia.
MANSFIELD MERRIMAN, South Bethlehem, Pa.
ALBERT LADD COLBY, South Bethlehem, Pa.
WILLIAM R. WEBSTER, "The Bartram," Thirty-third and Chestnut Streets, Philadelphia.

6. The management of the said corporation shall be vested in an Executive Committee, consisting of six (6) members, viz.: the Chairman, the Vice-Chairman, the Secretary, the Treasurer and two other members of the corporation, and such other officers as the corporation may from time to time appoint.

7. The corporation has no capital stock, and the members thereof shall be composed of the subscribers and their associates and of such persons as may from time to time be admitted by vote in such manner and upon such requirements as may be prescribed by the By-Laws. The corporation shall nevertheless have power to exclude, expel or suspend members for just or legal cause, and in such legal manner as may be ordained and directed by the By-Laws.

8. The By-Laws of this corporation shall be admitted and taken to be its laws subordinate to the statute aforesaid; this Charter; Constitution and Laws of the Commonwealth of Pennsylvania, and the Constitution of the United States; they shall be altered and amended as provided for by the By-Laws themselves; and shall prescribe the powers and functions of the Executive Committee herein mentioned and those to be hereafter elected, the times and places of meetings of the Committee and this corporation; the number of members who shall constitute a quorum at the meetings of the corporation, and of the Committee; the qualifications and manner of electing members; the manner of electing officers; and the powers and duties of such officers; and all other concerns and internal arrangements of the said corporation.

Witness our hands and seals this twenty-first day of March, A.D. 1902.

(Signed) EDGAR MARBURG,
R. W. LESLEY,
WM. R. WEBSTER,
MANSFIELD MERRIMAN,
ALBERT LADD COLBY.

BY-LAWS

Article I.

MEMBERS.

Section 1. The Society shall consist of Junior Members, Members and Honorary Members.

Sec. 2. A Member shall be a person not less than thirty years of age, corporation, firm, technical society, teaching faculty or library, proposed by two members and approved by the Executive Committee.

Sec. 3. A Junior Member shall be a person less than thirty years of age on the date of his admission, proposed by two members and approved by the Executive Committee. A Junior Member shall have the same rights and privileges as a Member, and his status shall be changed from that of Junior Member to Member at the beginning of the fiscal year next succeeding the date on which he attains the age of thirty years.

Sec. 4. An Honorary Member shall be a person of widely recognized eminence in some part of the field which the Society aims to cover as defined in Paragraph 2 of the Charter. The number of Honorary Members shall not exceed ten. A nominee for honorary membership shall be proposed by at least ten members and shall be elected only by unanimous vote of the Executive Committee.

Sec. 5. Applications for membership and resignation from membership must be transmitted in writing to the Secretary.

Article II.

OFFICERS AND THEIR ELECTION.

Section 1. The officers shall be a President, a First Vice-President, a Second Vice-President, and a Secretary-Treasurer.

Sec. 2. These officers shall be elected by letter ballot at the Annual Meetings. The President shall hold office for one year. The two Vice-Presidents and the Secretary-Treasurer shall hold office for two years. The term of office of the First Vice-President and of the Secretary-Treasurer shall expire in

the even years, and that of the Second Vice-President in the odd years.

SEC. 3. The Executive Committee shall consist of these officers and eight members, four being elected by letter ballot at each Annual Meeting. Four members of the Executive Committee shall constitute a quorum.

SEC. 4. The President, the two Vice-Presidents and the members of the Executive Committee shall be ineligible for re-election to the same office until at least one full term shall have elapsed after the end of their respective terms.

SEC. 5. The officers and members of the Executive Committee to hold office under these by-laws shall be as follows:

To hold office for one year:—the President elected this year (1912), the Second Vice-President, to be appointed by the Executive Committee, and the following members of the present Executive Committee: W. A. Bostwick, Robert W. Hunt, Richard Moldenke and William R. Webster.

To hold office for two years:—the First Vice-President elected this year (1912), the Secretary-Treasurer elected this year (1912), the three members of the Executive Committee elected this year (1912), and a fourth member to be appointed by the Executive Committee.

SEC. 6. The Secretary shall receive a salary to be fixed by the Executive Committee.

SEC. 7. The officers and members of the Executive Committee shall serve for the respective terms to which they shall have been elected, or until their successors shall have been duly elected.

SEC. 8. The Executive Committee shall have the power to fill any vacancies occurring in their number by death, resignation or otherwise.

SEC. 9. The election of officers and members of the Executive Committee shall be by letter ballot. The Executive Committee, before each Annual Meeting, shall appoint a Nominating Committee, whose duty it shall be to nominate a full list of officers. The list of nominations so made shall be submitted to the membership not more than eight (8) nor less than four (4) weeks before the coming Annual Meeting.

Further nominations, signed by at least ten (10) members, may be submitted to the Secretary in writing at least four (4) weeks before the Annual Meeting, and such nominations shall also be submitted to the membership on the official ballot.

Article III.

MEETINGS.

Section 1. The Society shall meet annually. The time and place of each meeting shall be fixed by the Executive Committee.

Sec. 2. Special meetings may be called whenever the Executive Committee shall deem it necessary, or upon the request in writing to the President of twenty-five (25) members.

Article IV.

PROCEDURE GOVERNING THE ADOPTION OF STANDARD SPECIFICATIONS.

Section 1. A proposed standard specification must be presented at the Annual Meeting, at which it may be amended by majority vote of those voting. A two-thirds affirmative vote of those voting shall be required to refer the specification to letter ballot of the Society. A two-thirds affirmative vote of those voting on letter ballot shall be required for the adoption of the specification.

Article V.

DUES.

Section 1. The fiscal year shall commence on the first of January. The annual dues shall be $10.00 for Members and $5.00 for Junior Members, payable in advance. Honorary Members shall not be subject to dues.

Sec. 2. Members or Junior Members holding membership also in the International Association for Testing Materials shall pay annually, in advance, the additional sum of $2.00, the fiscal year of the International Association beginning on the first of January, which sum shall be transmitted by the Treasurer to the International Association.

Sec. 3. Any Member or Junior Member may compound his dues at the beginning of any fiscal year by the purchase of a life membership, exempting him for life from annual dues, by the payment of the sum of one hundred and fifty dollars ($150); provided such membership is held by an individual. The cost

of life membership, or membership in perpetuity, to corporations, firms, technical societies, teaching faculties or libraries shall be two hundred dollars ($200).

SEC. 4. Any member of the Society whose dues shall remain unpaid for a period of three months from the beginning of the fiscal year shall receive a "Second Notice" from the Treasurer; if his dues shall remain unpaid for a period of five months from the beginning of the fiscal year, he shall forfeit the right to vote and to receive the publications of the Society. A month before the close of the fiscal year, he shall receive a final notice from the Treasurer that, if he neglects to pay his dues before the end of the fiscal year, his name may be stricken from the roll of membership by the Executive Committee.

SEC. 5. Any person elected after six months of any fiscal year shall have expired, shall pay only one-half of the amount of dues for that fiscal year; but he shall not be entitled to a copy of the Proceedings of the previous Annual Meeting.

SEC. 6. The resignation of a member whose dues for the current fiscal year are unpaid, shall be acceptable only if it be received within one month from the beginning of the fiscal year, unless an exception be authorized by special action of the Executive Committee.

ARTICLE VI.

AMENDMENTS.

SECTION 1. Proposed amendments to these By-Laws, signed by at last three members, must be presented in writing to the Executive Committee at least four weeks before the next Annual Meeting. In the notices for this meeting the proposed amendments shall be printed. At the Annual Meeting the proposed amendment may be discussed and amended and may be passed to letter ballot by a two-thirds vote of those present.

If two-thirds of the votes obtained by letter ballot are in favor of the proposed amendment, it shall be adopted.

SEC. 2. The Executive Committee is authorized to number the Articles and Sections of the By-Laws to corrsepond with any changes that may be made.

GENERAL INFORMATION.

International Association for Testing Materials.

Historical.—The International Association for Testing Materials had its origin in a conference of a small group of workers in experimental engineering held in Munich in 1882, at the instance chiefly of the late John Bauschinger. Meetings on a larger scale were subsequently held in Dresden (1884), Berlin (1886), Munich (1888), Vienna (1893), and Zurich (1895). At the Zurich Congress the International Association for Testing Materials was formally organized, the Second Congress was held at Stockholm in 1897, the Third Congress met at Budapest in 1901, the Fourth Congress met at Brussels in 1906, and the Fifth Congress met at Copenhagen in 1909. The Sixth Congress will be held in New York, September 2–7, 1912.

Membership.—The membership in May, 1912, was distributed as follows:

United States[1]	577	Spain	87	Luxembourg	11
Germany	424	Sweden	69	Chili	5
Russia (Finland, 27)	268	Italy	62	Panama	3
Austria	226	Holland	53	Servia	2
France	195	Norway	49	Argentine Republic	1
Denmark	159	Australia	39	China	1
Great Britain	138	Roumania	22	Greece	1
Belgium	126	Portugal	18	Guatemala	1
Hungary	114	Japan	15	India	1
Switzerland	97	Brazil	12		
		Canada	11		

Total (representing 30 countries).....2,787

Objects.—The objects of the Association, as set forth in its by-laws[2], are: "The development and unification of standard methods of testing; the examination of the technically important properties of materials of construction and other materials of practical value, and also the perfecting of apparatus used for this purpose." The important subject of specifications has, however, also been included more recently within the scope of the Association's activity.

[1] The American membership is now (August, 1912) 604.

[2] These by-laws are given in full on pages 536–539.

Administration.—The affairs of the Association are administered by a Council, consisting of the President and one representative (member of Council) from each country having a membership of twenty or more.

Methods.—The original plan was to conduct investigations almost exclusively through the agencies of international committees. These committees proved unwieldy, however, by reason of their large membership, with the added difficulties arising from geographical separation and differences of language. In pursuance of resolutions at the Budapest Congress (1901) the Council has discharged some of these committees, re-assigning the problems in part to individual referees. In the case of questions of direct international concern, the original international committees are continued. At the International Congresses the reports of these committees as well as individual contributions by members are presented and discussed.

Publications.—The publications of the International Association consist of Proceedings, issued in pamphlet form at irregular intervals during the year, of which the first number was published in May, 1908, and the last to date, No.13, Vol. II, in August, 1912. These Proceedings are printed in German, English and French, and contain the papers and committee reports presented at the International Congresses, the minutes of the Council, official communications, membership lists, personnel of technical committees, etc. Separate pamphlets of the Proceedings in English may be obtained, at prices ranging from 25 to 75 cents a copy, from the Secretary of the American Society. The price of Vol. I complete, consisting of Nos. 1–15 inclusive, is $5.00.[1]

ORGANIZATION OF THE AMERICAN MEMBERS OF THE INTERNATIONAL ASSOCIATION.

Historical.—With a view of bringing the members of like nationality into closer relations among themselves, and in order to simplify the management and render the work of the International Association more effective, it was decided at the Stockholm

[1]The papers presented at the Brussels Congress, 1906, may be obtained from the Secretary of the American Society at the following prices:

Official Papers, per set	$1.50
Non-Official Papers, per set	2.50

Separate copies of above papers, 10-20 cents.

A list of these official and non-official papers may be had by addressing the Secretary of the American Society.

Congress (1897) to encourage the consolidation of the membership in the various countries into separate national organizations. In pursuance of this action the American members met in Philadelphia on June 16, 1898, and organized under the name of the "American Section of the International Association for Testing Materials."

In March, 1902, the Executive Committee of the American Section applied for a Charter under the laws of the State of Pennsylvania for purposes of incorporation under the proposed new name of the "American Society for Testing Materials." This Charter was duly granted, and at the Fifth Annual Meeting held at Atlantic City, N. J., it was unanimously adopted on June 12, 1902.

At the Eighth Annual Meeting (1905), the by-laws were amended with a view of leaving membership in the International Association to the individual option of the members of the American Society. This amendment was adopted by letter ballot of the Society.

Objects.—The objects of the Society are essentially identical with those of the International Association, with which it stands in direct organic relation, both through its membership in the same as a body, and through the individual membership on the part of many of its members.

As stated in the Charter: "The corporation is formed for the promotion of knowledge of the materials of engineering, and the standardization of specifications and the methods of testing."

The standardization of specifications is considered one of the most important functions of the Society. The method of procedure is to submit proposed standard specifications prepared by the various committees for general discussion at the annual meetings of the Society. The specifications in their original or amended form may then be referred, by two-thirds vote of those voting, to letter ballot of the Society subject to adoption as Standard Specifications by two-thirds vote of those voting. A list of the Standard Specifications thus far adopted by the Society is given on pages 96-103.

Representation on the International Council.—The American members are entitled to one representative on the International Council. By the By-Laws of the Association (1909): "Every country represented in the Association by at least twenty members has the right to elect one member as member of the Council."

Meetings.—The Society meets annually at a time and place fixed by the Executive Committee. Special meetings may also be called in accordance with the provisions of the by-laws.

Membership.—The number of American members at the time of the organization meeting in 1898 was 70. The membership reported at the successive annual meetings was as follows: (1899) 128, (1900) 160, (1901) 168, (1902) 175, (1903) 349, (1904) 485, (1905) 677, (1906) 835, (1907) 925, (1908) 1,015, (1909) 1,160, (1910) 1,280, (1911) 1,382, (1912) 1,430.

Methods.—The operations of the Society are conducted in part under the auspices of the International Association, but for the most part independently.

The number of American representatives on international committees is fixed by the International Council. These American sub-committees are authorized, however, to increase their number, at pleasure, subject always to the approval of the Executive Committee of the American Society. The sense of these enlarged sub-committees on all questions is determined by majority vote; but on the international committees the representation and the number of votes allowed remain as originally fixed by the International Council.

The American Society appoints other committees at its discretion entirely independently of the International Association. On committees concerned with subjects involving commercial interests, the policy is to accord equal numerical representation to engineers or scientists, and to manufacturers, the former being allowed to predominate numerically with the consent of the latter.

Many of these committees have rendered a useful service in the origination of proposed standard specifications for materials and for methods of testing. Such proposed specifications on approval by majority vote of the committees concerned are submitted to the Society at its annual meetings, when the specifications may be discussed, amended, and referred to letter ballot of the Society by two-thirds vote of those voting. The final adoption of the specifications by letter ballot is contingent on an affirmative two-thirds vote of those voting.

The personnel of the Technical Committees of the American Society is indicated on pages 511-530.

Publications.—The publications of the Society appeared originally at irregular intervals in the form of bulletins. Twenty-eight bulletins, containing a total of 226 pages, were thus issued.

Since 1902 the Proceedings have appeared in the form of annual volumes. In passing to this new plan of publication the twenty-eight bulletins previously issued were counted collectively as Volume I. The Table of Contents of the Proceedings issued by the Society, with price list, is given on pages 567-588.

In 1910, the Society began the publication of a Year-book containing all the standard specifications in their latest revised form, besides the by-laws, list of members, committees, and other information concerning the Society. Each standard specification is also published in separate form. The price list for the Year-book and for the separate specifications is given on page 103.

LIST OF STANDARD SPECIFICATIONS

ADOPTED BY THE

AMERICAN SOCIETY FOR TESTING MATERIALS.

These standard specifications are all copyrighted in the name of the American Society for Testing Materials. Permission to reprint any of these specifications can be obtained only from the Executive Committee on application to the Secretary.

A. FERROUS METALS.

1. Standard Specifications for Bessemer Steel Rails.[1]

   Proposed May, 1900 (Vol. I, pp. 101–105).
   Adopted in amended form August 10, 1901 (Vol. I, p. 253).
   First revision adopted September 1, 1907 (Vol. VII, pp. 44–47).
   Second revision adopted August 15, 1908 (Vol. VIII, pp. 44–47).
   Third revision adopted August 16, 1909 (Vol. IX, pp. 62-63).

2. Standard Specifications for Open-hearth Steel Rails.

   Proposed June, 1909.
   Adopted August 16, 1909 (Vol. IX, pp. 66–69).

3. Standard Specifications for Open-hearth Girder and High Tee Rails.

   Proposed March, 1912.
   Adopted June 1, 1912 (Vol. XII, pp. 122–126).

4. Standard Specifications for Steel Splice Bars.

   Proposed May, 1900 (Vol. I, pp. 107–109).
   Adopted in amended form August 10, 1901 (Vol. I, p. 253).
   First revision adopted August 16, 1909 (Vol. IX, pp. 56–57).
   Second revision adopted June 1, 1912 (Vol. XII, pp. 127–128).

5. Standard Specifications for Structural Steel for Bridges.[2]

   Proposed May, 1900 (Vol. I, pp. 81–86).
   Adopted in amended form August 10, 1901 (Vol. I, p. 250).
   First revision adopted September 1, 1905 (Vol. V, pp. 48–52).
   Second revision adopted August 16, 1909 (Vol. IX, pp. 37–41).

[1] These specifications were designated "Standard Specifications for Steel Rails," till the adoption, August 16, 1909, of separate "Standard Specifications for Open-hearth Steel Rails."

[2] These specifications, when first adopted in 1901, were combined with the Specifications for Structural Steel for Ships under the title "Standard Specifications for Structural Steel for Bridges and Ships." In 1905, these latter specifications were made to apply to ship material only, by striking out the words "*Bridges and*" from the title, and revised "Standard Specifications for Structural Steel for Bridges" were adopted.

6. Standard Specifications for Structural Nickel Steel.

Proposed March, 1912.
Adopted June 1, 1912 (Vol. XII, pp. 135–140).

7. Standard Specifications for Structural Steel for Buildings.

Proposed May, 1900 (Vol. I, pp. 87–92).
Adopted in amended form August 10, 1901 (Vol. I, p. 250).
First revision adopted August 16, 1909 (Vol. IX, pp. 47–50).

8. Standard Specifications for Structural Steel for Ships.[1]

Proposed May, 1900 (Vol. I, pp. 81–86).
Adopted in amended form August 10, 1901 (Vol. I, p. 250).
First revision adopted August 16, 1909 (Vol. IX, pp. 42–46).

9. Standard Specifications for Boiler and Firebox Steel.[2]

Proposed March, 1912.
Adopted June 1, 1912 (Vol. XII, pp. 152–156).

10. Standard Specifications for Boiler Rivet Steel.[2]

Proposed March, 1912.
Adopted June 1, 1912 (Vol. XII, pp. 157–160).

11. Standard Specifications for Steel Reinforcing Bars.

Proposed June, 1911.
Adopted August 21, 1911 (Vol. XI, pp. 66–68).
First revision adopted June 1, 1912 (Vol. XII, pp. 161–164).

12. Standard Specifications for Steel Axles.

Proposed May, 1900 (Vol. I, pp. 111–114).
Adopted in amended form August 10, 1901 (Vol. I, p. 254).
First revision adopted September 1, 1905 (Vol. V, pp. 56–58).

13. Standard Specifications for Heat-treated Carbon-steel Axles, Shafts, and Similar Objects.

Proposed June, 1911.
Adopted August 21, 1911 (Vol. XI, pp. 63–65).
First revision adopted June 1, 1912 (Vol. XII, pp. 169–173).

14. Standard Specifications for Forged and Rolled, Forged, or Rolled Solid Carbon-steel Wheels for Engine-truck, Tender, and Passenger Service.

Proposed June, 1911 (Vol. XI, pp. 55–58).
Adopted in amended form June 1, 1912 (Vol. XII, p. 174–178).

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[1] See Standard Specifications for Structural Steel for Bridges.

[2] These specifications supersede the standard specifications for Open-hearth Boiler Plate and Rivet Steel, which were proposed in May, 1900, adopted in amended form August 10, 1901, and revised August 16, 1909 (Vol. IX, pp. 51–55).

15. Standard Specifications for Forged and Rolled, Forged, or Rolled Solid Carbon-steel Wheels for Freight-car Service.

Proposed June, 1911 (Vol. XI, pp. 59–62).
Adopted in amended form June 1, 1912 (Vol. XII, pp. 179–183).

16. Standard Specifications for Steel Tires.

Proposed May, 1900.
Adopted August 10, 1901 (Vol. I, pp. 115–118).
First revision adopted August 16, 1909 (Vol. IX, pp. 58–61).

17. Standard Specifications for Steel Forgings.

Proposed May, 1900 (Vol. I, pp. 119–123).
Adopted in amended form August 10, 1901 (Vol. I, p. 254).
First revision adopted September 1, 1905 (Vol. V, pp. 59–62).

18. Standard Specifications for Steel Castings.

Proposed May, 1900.
Adopted August 10, 1901 (Vol. I, pp. 125–128).
First revision adopted September 1, 1905 (Vol. V, pp. 53–55.)
Second revision adopted June 1, 1912 (Vol. XII, pp. 192–195).

19. Standard Specifications for Automobile Carbon and Alloy Steels.

Proposed March, 1912.
Adopted June 1, 1912 (Vol. XII, pp. 196–203).

20. Recommended Practice for Annealing Miscellaneous Rolled and Forged Carbon-steel Objects.

Proposed June, 1911.
Adopted August 21, 1911 (Vol. XI, pp. 86–91).

21. Standard Magnetic Tests of Iron and Steel.

Proposed June, 1911.
Adopted August 21, 1911 (Vol. XI, pp. 110–114).
First revision adopted June 1, 1912 (Vol. XII, pp. 210–214).

22. Standard Specifications for Engine-bolt Iron.[1]

Proposed March, 1912.
Adopted June 1, 1912 (Vol. XII, pp. 215–217).

23. Standard Specifications for Refined Wrought-iron Bars.[1]

Proposed March, 1912.
Adopted June 1, 1912 (Vol. XII, pp. 218–221).

[1] These specifications supersede the standard specifications for Wrought Iron, which were proposed in May, 1900, and adopted in amended form August 10, 1901 (Vol. I, pp. 231–235)

24. Standard Specifications for Foundry Pig Iron.

Proposed June, 1904 (Vol. IV, p. 44).
Adopted in amended form November 15, 1904 (Vol. IV, pp. 103–104).
First revision adopted August 16, 1909 (Vol. IX, pp. 111–112).

25. Standard Specifications for Cast-iron Pipe and Special Castings.

Proposed June, 1904.
Adopted November 15, 1904 (Vol. IV, pp. 57–66.)

26. Standard Specifications for Locomotive Cylinders.

Proposed June, 1904 (Vol. IV, pp. 69–70).
Adopted in amended form November 15, 1904 (Vol. IV, p. 69).
Revised specifications proposed June, 1911 (Vol. XI, pp. 83–84).

27. Standard Specifications for Cast-iron Car Wheels.

Proposed June, 1904 (Vol. IV, pp. 74–79).
Adopted in amended form September 1, 1905 (Vol. V, pp. 65–70).

28. Standard Specifications for Gray-iron Castings.

Proposed June, 1904 (Vol. IV, pp. 97–100).
Adopted in amended form September 1, 1905 (Vol. V, pp. 71–74).

29. Standard Specifications for Malleable Castings.

Proposed June, 1904 (Vol. IV, pp. 95–96).
Adopted in amended form November 15, 1904 (Vol. IV, p. 96).

30. Standard Specifications for Annealed Steel Forgings.

Proposed March, 1912.
Adopted June 1, 1912 (Vol. XII, pp. 250–253).

31. Standard Specifications for Steel Shapes, Universal Mill Plates, and Bars.

Proposed March, 1912.
Adopted June 1, 1912 (Vol. XII, pp. 254–257).

32. Standard Specifications for Lap-welded and Seamless Steel Boiler Tubes and Safe Ends, $2\frac{1}{2}$ in. Diameter and under

Proposed March, 1912.
Adopted June 1, 1912 (Vol. XII, pp. 258–260).

33. Standard Specifications for Staybolt Iron.[1]

Proposed June, 1907 (Vol. VII, pp. 157–158).
Adopted in amended form September 1, 1910 (Vol. X, pp. 94-95)
First revision adopted June 1, 1912 (Vol. XII, pp. 261–263).

[1] These specifications supersede the standard specifications for Wrought Iron, which were proposed in May, 1909, and adopted in amended form August 10, 1901 (Vol. I, pp. 231–235).

34. Standard Specifications for Lap-welded Iron Boiler Tubes.
Proposed March, 1912.
Adopted June 1, 1912 (Vol. XII, pp. 264–266).

B. NON-FERROUS METALS.

35. Standard Specifications for Hard-drawn Copper Wire.
Proposed June, 1909.
Adopted August 16, 1909 (Vol. IX, pp. 311–318).
First revision adopted August 21, 1911 (Vol. XI, pp. 132–138).

36. Standard Specifications for Medium Hard-drawn Copper Wire.
Proposed March, 1912.
Adopted June 1, 1912 (Vol. XII, pp. 277–285).

37. Standard Specifications for Soft or Annealed Copper Wire.
Proposed March, 1912.
Adopted June 1, 1912 (Vol. XII, pp. 286–291).

38. Standard Specifications for Copper-wire Bars, Cakes, Slabs, Billets, Ingots, and Ingot Bars.
Proposed June, 1911.
Adopted August 21, 1911 (Vol. XI, pp. 143–145).

39. Standard Specifications for Spelter.
Proposed June, 1911.
Adopted August 21, 1911 (Vol. XI, pp. 146–149).

40. Standard Specifications for Manganese-bronze Ingots.
Proposed June, 1911.
Adopted August 21, 1911 (Vol. XI, pp. 150–151).

C. CEMENT, LIME, AND CLAY PRODUCTS.

41. Standard Specifications for Cement.
Proposed June, 1904.
Adopted November 15, 1904 (Vol. IV, pp. 105–119).
First revision adopted August 15, 1908 (Vol. VIII, pp. 149–164).
Second revision adopted August 16, 1909 (Vol. IX, pp. 116–130).

42. Standard Test for Fireproof Floor Construction.
Proposed June, 1906 (Vol. VI, pp. 126–128).
Adopted September 1, 1907 (Vol. VII, pp. 179–180).
First revision adopted August 15, 1908 (Vol. VIII, pp. 210–212)

43. Standard Test for Fireproof Partition Construction.

Proposed June, 1908 (Vol. VIII, pp. 207–209).
Adopted August 16, 1909 (Vol. IX, pp. 281–282).

D. MISCELLANEOUS MATERIALS.

44. Standard Abrasion Test for Road Material.

Proposed June, 1904 (Vol. IV, pp. 193–194).
Adopted August 15, 1908 (Vol. VIII, pp. 197–198).

45. Standard Toughness Test for Macadam Rock.

Proposed June, 1905 (Vol. V, pp. 102–103).
Adopted August 15, 1908 (Vol. VIII, pp. 199–200).

46. Provisional Method for the Determination of Soluble Bitumen.

Proposed June, 1911.
Adopted August 21, 1911 (Vol. XI, pp. 245–246).

47. Provisional Method for the Determination of the Penetration of Bitumen.

Proposed June, 1911.
Adopted August 21, 1911 (Vol. XI, p. 247).

48. Provisional Method for the Determination of the Loss on Heating of Oil and Asphaltic Compounds.

Proposed June, 1911.
Adopted August 21, 1911 (Vol. XI, p. 248).

49. Provisional Method of Sizing and Separating the Aggregate in Asphalt Paving Mixtures.

Proposed June, 1911.
Adopted August 21, 1911 (Vol. XI, p. 249).

50. Standard Classification of Structural Timber.[1]

I. Definition of Structural Timber.
II. Standard Defects.
III. Standard Names for Structural Timber.

Proposed June, 1906 (Vol. VI, pp. 129–133).
Adopted in amended form September 1, 1907 (Vol. VII, pp. 187–192).

[1] These specifications originally included "Standard Specifications for Bridge and Trestle Timbers," and were designated "Standard Specifications for Structural Timber" till the adoption, September 1, 1910, of separate "Standard Specifications for Yellow-pine Bridge and Trestle Timbers."

51. Standard Specifications for Yellow-pine Bridge and Trestle Timbers.

Proposed June, 1909 (Vol. IX, pp. 283–286).
Adopted September 1, 1910 (Vol. X, pp. 159–161).

E. MISCELLANEOUS SUBJECTS.

52. Standard Methods of Testing.

I. Methods for Tensile Tests of Metals.

II. Methods for Compressive Tests of Metals.

I and II: Proposed June, 1909 (Vol. IX, pp. 263–270).
Adopted September 1, 1910.

III. Methods for Transverse Tests of Metals.

Proposed June, 1911.
Adopted August 21, 1911 (Vol. XI, pp. 259–261).

IV. Methods for Metallographic Tests of Metals.

Proposed June, 1909 (Vol. IX, pp. 270–272).
Adopted September 1, 1910.

53. Standard Definitions of Terms Applicable to Materials Relating to Roads and Pavements.

Proposed March, 1912.
Adopted August 5, 1912 (Vol. XII, p. 362).

PRICE LIST OF STANDARD SPECIFICATIONS.

The prices of the above Standard Specifications are as follows:

Single copies						25 cents.		
For lots of	10	to	25			20 cents	each.	
" " "	25	"	100			15	"	"
" " "	100	"	500			10	"	"
" " "	500	"	1,000			7½	"	"
" " "	1,000	and	over			5	"	"

Since the numeric designation of the Standard Specifications is subject to change from year to year, specifications should be ordered by title and not by number.

Members of the Society may obtain extra copies of the Standard Specifications at the following prices:

Single copies	15 cents.
For lots of 10 to 100	10 cents each.
Lots above 100, as per price list above.	

The price of the Year-book in cloth binding containing all the Standard Specifications in their latest revised form is $5.00. Members of the Society may obtain extra copies of the Year-book at the special price of $3.00. Libraries, publishers and book-dealers are allowed a discount of 20 per cent.

EXTRACT RELATING TO SPECIFICATIONS

FROM

REGULATIONS GOVERNING TECHNICAL COMMITTEES.

Proposed new and standard specifications or the proposed amendment of existing specifications must originate in the particular committee within whose province such specifications properly belong. No action affecting specifications shall be taken by any technical committee except at meetings called for that purpose. Action at such meetings shall be subject to majority vote of those voting, and subsequently to majority vote of those voting on letter ballot of the entire committee. Dissenting members shall have the right to present minority reports, individually or jointly, at the annual meeting of the Society at which the majority report is presented.

Any recommendations affecting specifications presented by the appropriate committees at the annual meetings of the Society may be amended by a majority vote of those voting, and the final adoption of new or amended specifications shall be subject to the following procedure:

1. Approval at an annual meeting by two-thirds vote of those voting.
2. Approval by letter ballot of the Society by two-thirds vote of those voting.

REGULATIONS GOVERNING THE FORM BUT NOT THE SUBSTANCE OF SPECIFICATIONS, STANDARD METHODS OF TESTS, ETC.

1. These Regulations shall not be retroactive with respect to existing specifications, although they may be applied to such specifications on the recommendation of, or with the consent of, the technical committee concerned.

2. These Regulations have been adopted with the understanding (1) that the technical committees shall make an earnest effort to comply with these Regulations; (2) that departures from these Regulations shall not be made by the technical committees except on what they believe to be strong grounds; (3) that the judgment of the technical committees concerning such departures shall, in general, be regarded as conclusive; but that in case of disagreement on matters which the Executive Committee of Committee E-5 may regard as of sufficient importance, it shall have the right to appeal to the Executive Committee of the Society, whose decisions in all such matters shall be final.

3. These Regulations shall be subject to annual review and revision by Committee E-5.

(A) ARRANGEMENT, LETTERING AND NUMBERING.

4. The material in each specification shall be grouped under sub-titles, numbered consecutively by Roman numerals. The principal divisions under a sub-title shall be designated by upper-case Roman letters, in parentheses: (A), (B), (C), etc.

5. The sections in each specification shall be numbered continuously by Arabic numerals. Sub-divisions under a single section shall be distinguished by lower-case italics, in parentheses: (*a*), (*b*), (*c*), etc. This side-lettering shall not run continuously throughout a given specification, but shall begin with (*a*) in each section.

6. The general arrangement of standard specifications shall be as follows:

TITLE.

Matter of an introductory or general nature (see Section 7, below).

I. SUB-TITLE.

(A) Principal divisions under a sub-title.

1. Sections (numbers to run consecutively throughout the specification).

(*a*) Sub-divisions of a section (letters to run consecutively throughout a section only).

(B) FORM AND SEQUENCE OF SUB-TITLES.

7. Directly after the title of the specification insert sections of an introductory, descriptive or general character, for example, matter descriptive of the products the specifications are designed to cover. No sub-title shall be used for such matter. Such terms as" introductory," "general," etc., are lacking in definite meaning, and may in some cases be wholly inappropriate.

8. The matter following these opening sections (if any) shall be grouped in general under the following sub-titles in the sequence indicated.

I. MANUFACTURE.

II. CHEMICAL PROPERTIES AND TESTS.

III. PHYSICAL PROPERTIES AND TESTS.

(A) Mechanical.
(B) Electrical.
(C) Magnetic.
(D) Thermal.
(E) Other properties and tests under appropriately descriptive headings.

Under II and III the method of sampling and the standard test specimens shall be defined.

IV. STANDARD SIZES, DIMENSIONS, WEIGHTS, GAGES, ETC.

9. This sub-title is to be used in a form appropriate to the matter to which it refers and shall be followed immediately by

appropriate sections covering "permissible variations." If the matter under "permissible variations" is lengthy and contains numerous sections, as for example, in the Standard Specifications for Structural Steel for Bridges, an appropriate special sub-title shall be used. Such a sub-title shall also be used in case the specification contains no matter under Sub-Title IV.

V. WORKMANSHIP AND FINISH.

VI. PACKING, MARKING AND SHIPPING.

10. If the sections under Sub-Title VI are limited in a given specification to only one or two of the above three items, the sub-title shall be abridged accordingly.

VII. INSPECTION AND REJECTION.

11. The term "inspection" shall be interpreted here in the restricted sense of surface or outward inspection of the finished product.

VIII. DEFINITION OF TERMS.

12. If a specification contains numerous terms that admit of ambiguity, they shall be defined under this sub-title. If, on the other hand, a specification contains only a few such terms, they shall preferably be defined where they are first used. The definition of the same term in different specifications shall, if possible, be identical.

IX. SPECIAL SUB-TITLES.

13. Sections that cannot appropriately be placed under any of the above sub-titles shall be grouped under special sub-titles, inserted in their most logical position. Such special sub-titles shall be indicative of the contents of the sections to which they pertain. The use of such sub-titles as "General," "Miscellaneous," etc., shall be avoided.

14. In so far as the above standard sub-titles are used, the sequence in which they are given above shall, if possible, be adhered to.

(C) MARGINAL HEADINGS.

15. Every numbered section shall have a marginal heading in bold-face type, briefly indicative of its content.

16. The sequence of matter under a given sub-title shall be left to the judgment of the committee concerned. In so far as possible, the same sequence of marginal headings shall be observed in different specifications prepared by a given committee. The requirements for specifications prepared by different committees vary so widely, that it is not considered practicable to extend this provision to the work of different committees. The Secretary of the Society shall endeavor, however, to secure such uniformity between specifications prepared by different committees.

(D) SPECIFIED VALUES.

17. "Desired values" rather than "permissible limits" shall be given, followed by a statement with respect to "permissible variations." The term "permissible variations" shall be used in general, rather than the term "tolerance," except in connection with subjects in which the latter term is in better accord with recognized trade usage.

18. In so far as practicable, specified values shall be expressed in tabular form.

(E) UNITS OF MEASUREMENT.

19. Units of measurement shall be expressed in both the English and Metric systems, if, in the judgment of the committee concerned, it is desirable to do so. Temperatures shall be expressed in Centigrade values, and also in Fahrenheit values, if, in the judgment of the committee concerned, it is desirable to do so.

(F) TYPOGRAPHY, STANDARD TERMS, ABBREVIATIONS, SPELLING, ETC.[1]

20. Committee E-5 shall have final authority in all matters pertaining to typography, standard terms and forms of expression, abbreviations, spelling, etc.

[1] This matter has been adapted in large part from the Style Sheet of the American Society of Mechanical Engineers.

21. ABBREVIATIONS.

When abbreviations are used, they shall conform to the following requirements:

(a) Units of Length.

Centimeter	cm.
Decimeter	dm.
Foot	ft.
Inch	in.
Kilometer	km.
Linear	lin.
Meter	m.
Mile	mile
Millimeter	mm.
Yard	yd.

(b) Units of Area.

Are (= 100 sq. m.)	are
Circular mil	cir. mil.
Hectare	ha.
Square	sq.

(c) Units of Volume.

Barrel	bbl.
Bushel	bu.
Centiliter	cl.
Cubic	cu.
Cubic centimeter	cc.
Decaliter	dal.
Decileter	dl.
Gallon	gal.
Hectoliter	hl.
Liter	l.
Milliliter	ml.
Stere (= 1 cu. m.)	s.
Volume	vol.

(d) Units of Weight.

Centigram	cg.
Decigram	dg.
Grain	gr.
Gram	g.
Kilogram	kg.
Milligram	mg.
Ounce	oz.
Pound	lb.
Ton	ton

(e) Units of Time.

Afternoon	p. m.
Day	day
Forenoon	a. m.
Hour	hr.
Minute	min.
Month	month
Second	sec.
Week	week
Year	year

(f) Electrical and Magnetic Terms.

Ampere	ampere
Electric horse power	e. h. p.
Electromotive force	e. m. f.
Magnetomotive force	m. m. f.
Ohm	ohm
Volt	volt

(g) Units of Power.

Brake horse power	b. h. p.
Horse power	h. p.
Indicated horse power	i. h. p.
Kilowatt	kw.
Watt	watt

(h) Units of Heat.

British thermal unit	B. t. u.
Calorie	cal.
Centigrade	C.
Degree	°
Fahrenheit	F.

ABBREVIATIONS (*Continued*).

(*i*) *Miscellaneous Terms.*

Birmingham wire gage	B. w. g.	Number	No.
Browne & Sharpe (gage)	B. & S.	Per	per
Chemically pure	c. p.	Per centum	per cent
Degree (angular measure)	deg.	Revolutions per minute	r. p. m.
Diameter	diameter	Specific gravity	sp. gr.
Figure	Fig.	Unites States (gage)	U. S.

(*j*) *Compound Words.*—The abbreviations for compound words, when used, shall be formed by connecting the abbreviations of the separate words by a hyphen, omitting the period preceding the hyphen. Thus, "ft-lb., watt-hr., kw-hr., m-kg.," etc.

(*k*) *Symbols.*—Avoid the use of symbols. Do not use (′) or (″), in either text or tables; their use is permissible in illustrations. The symbol (%) shall not be used in the text, but may be used in tables when lack of space demands it.

(*l*) The word "percentage" shall be used when not following a number. Thus, "the *percentage* of carbon shall be;" not, "the *per cent* of carbon shall be." But, "0.35 *per cent* of carbon."

(*m*) The above terms, when used in an abstract or descriptive sense, shall not be abbreviated. For example, use "the *magnetomotive force* is applied;" not, "the *m.m.f.* is applied."

(*n*) All abbreviations shall be used in the singular. Thus, "two inches" shall be abbreviated "2 in.;" not "2 ins."

(*o*) In expressing dimensions, use the following form: "2 *by* 4 in., in section;" not "2 x 4 in. in section."

(*p*) After numerals, use the following abbreviations: 62° F., 36° C. In a table heading, use "Temperature, *deg.* F.," or "*deg.* C."

(*q*) When "tensile strength" is abbreviated, use "tens. str."

(*r*) In text, do not abbreviate "namely" and "that is."

22. NUMERALS.

(*a*) Spell out all numbers from one to twelve, with the following exceptions:

1. Use numerals when the quantity is partly or wholly fractional: as, 1.15, $1\frac{1}{2}$, $\frac{1}{3}$.

2. Use numerals when followed by an expression having a standard abbreviation: as, 1 in., 6 lb., etc.; except where the statement is vague in nature, in which case neither numerals nor abbreviations shall be used: as, "about *six* pounds," etc.

3. If for any reason the standard abbreviation of the expression following the number is not used, or if the expression does not admit of abbreviation (as *ohm*, *ton*, etc.) the use of numerals shall be optional, unless covered in the following paragraphs.

4. In contrasted statements, if some numbers must be numerals, use numerals for all: as, "2 miles and 16 miles."

5. In a series of connected numerical statements implying precision, use numerals: as, "2 years, 5 months, 3 days." The use of numerals (especially the "1") is not recommended for numbers occurring in precise statements similar to the following: "By connecting the *two* test coils;" "shall consist of *two* equal and uniformly wound solenoids," etc.

6. Use numerals after abbreviations: as, Vol. 6, Fig. 2, etc.

(*b*) Use numerals for all numbers exceeding twelve, with the following exceptions:

1. Never begin a sentence with a numeral.

2. Round numbers used in an indefinite sense shall be spelled out: as, "A *hundred* feet or so," etc.

3. Numbers shall be spelled out when used in the following manner: *ten* 2-in. rods," etc.

(*c*) In expressing percentages, precise figures, etc., use decimals: as, "4.5 per cent;" not "$4\frac{1}{2}$ per cent."

(*d*) In decimal numbers having no units, a cipher shall be placed before the decimal point: as, "0.65 in.;" not ".65 in."

(*e*) Omit unnecessary ciphers in sums of money: as, "$3;" not "$3.00."

(*f*) In pointing off numbers of more than four figures, use commas in the text (1,234,567) and spaces in tabular matter (1 234 567). Numbers of four figures shall not be pointed off in the text (1234), but shall be in tabular work (1 234).

(*g*) Use January 25, not January 25*th*.

23. SPELLING AND PUNCTUATION.

(*a*) *Simple Words.*—The following spelling shall be used:

center	mold
fiber	program
gage	reinforced

(*b*) *Compound Words.*—The following spelling shall be used:

Spell with hyphen.	*Spell without hyphen.*
cold-rolled } when used as verbs	cast iron
rough-forged } or adjectives	cooperate
cross-head	engine bolt
cross-section	eye bar
one-half	firebox
re-anneal	fireproof
re-rolled	reheat
re-treat	retest
	sinkhead
	staybolt
	testing machine
	wrought iron

(*c*) Compound adjectives shall be hyphenated; as "2-in. gage," "cast-iron cylinder," etc. Such expressions as the following shall be written *without* the hyphen after the first numeral: "2- and 4-in. specimens."

(*d*) Do not hyphenate such expressions as "newly puddled iron," where the adverb is a regular modifier of the adjective.

(*e*) The word *per cent* shall be spelled without a period.

24. CAPITALS.

(*a*) In titles in which the upper-case letters are used only for initial letters, use lower-case initial letters for the second word in compound words: as, "Cold-rolled Axles," not "Cold-Rolled Axles"; except when the first word is a prefix, in which case use upper-case initial letters for the second word also: as, "Sub-Title," "Vice-President," etc.

(*b*) Use capital initial "B" for Bessemer; "P" for Portland.

(*c*) Use initial capitals in reference to volumes, figures, plates, etc.: as, Vol. 6, Fig. 2, Plate VI.

25. STANDARD TERMS AND FORMS OF EXPRESSION.

(*a*) Use "Section" instead of "Paragraph" in referring to numbered sections in specifications.

(*b*) Use "shall" wherever the specifications are to be made binding on parties of the first or second part.

(*c*) Use "will" wherever the specifications are intended to express a declaration of purpose not mandatory upon the parties of the first or second part.

(*d*) Use "may" wherever the specifications provide definitely for alternative courses.

(*e*) Use "full-size tests;" not "full-sized tests," etc.

(*f*) Use "gage length;" not "gaged length."

(*g*) Use "test *specimen;*" not "test *piece.*" In case the term "test specimen" is repeated several times in the same section, the word "specimen" may be used after the first use of "test specimen."

(*h*) Use "$\frac{3}{8}$ in. *or* more in thickness;" not "$\frac{3}{8}$ in. *and* more."

(*i*) In referring to dimensions, use "2 in.;" not "two inches (2 in.)," or "two (2) inches."

(*j*) Use "without fracture" in referring to bend tests; not "without *sign of* fracture."

(*k*) Use "melt" to mean "melt of steel," "blow of steel," and "heat of steel," as distinguished from "treating-plant heat," etc.

AMERICAN SOCIETY FOR TESTING MATERIALS

PHILADELPHIA, PA., U. S. A.

AFFILIATED WITH THE

INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.

STANDARD SPECIFICATIONS FOR BESSEMER STEEL RAILS.

ADOPTED AUGUST 16, 1909.

Process of Manufacture.

1. (*a*) The entire process of manufacture and testing shall be in accordance with the best current practice, and special care shall be taken to conform to the following instructions:

(*b*) Ingots shall be kept in a vertical position in the pit heating furnaces until ready to be rolled or until the metal in the interior has time to solidify.

(*c*) No bled ingots shall be used.

(*d*) There shall be sheared from the end of the blooms formed from the top of the ingots not less than *x* per cent.,* and if, from any cause, the steel does not then appear to be solid, the shearing shall continue until it does.

Chemical Composition.

2. Rails of the various weights per yard specified below shall conform to the following limits in chemical composition:

	50 to 60 lbs. Per cent.	61 to 70 lbs. Per cent.	71 to 80 lbs. Per cent.	81 to 90 lbs. Per cent.	91 to 100 lbs. Per cent.
Carbon	0.35-0.45	0.35-0.45	0.40-0.50	0.43-0.53	0.45-0.55
Phosphorus, not over	0.10	0.10	0.10	0.10	0.10
Silicon, not over	0.20	0.20	0.20	0.20	0.20
Manganese	0.70-1.00	0.70-1.00	0.75-1.05	0.80-1.10	0.84-1.14

*The percentage of minimum discard in any case to be subject to agreement, and it should be recognized that the higher this percentage the greater will be the cost.

Shrinkage.

3. The number of passes and speed of train shall be so regulated that on leaving the rolls at the final pass, the temperature of rails of sections 75 lbs. per yard and heavier will not exceed that which requires a shrinkage allowance at the hot saws of $6\frac{7}{16}$ ins. for a 33-ft. 75-lb. rail, with an increase of $\frac{1}{16}$ in. for each increase of 5 lbs. in the weight of the section.

No artificial means of cooling the steel shall be used after the rails leave the rolls, nor shall they be held before sawing for the purpose of reducing their temperature.

Drop Test.

4. One drop test may be made on a piece of rail not less than 4 ft. and not more than 6 ft. long, selected from each blow of steel.

The rails shall be placed head upward on the supports and the various sections shall be subjected to the following impact tests under a free falling weight:

Weights of rail per yard.	Height of drop in feet.
50 to 60 lbs.	15
61 to 70 lbs.	16
71 to 80 lbs.	16
81 to 90 lbs.	17
91 to 100 lbs.	18

If any rail breaks when subjected to the drop test, two additional tests will be made of other rails from the same blow of steel, and if either of these latter tests fail, all the rails of the blow which they represent will be rejected; but if both of these additional test pieces meet the requirements all the rails of the blow which they represent will be accepted.

Drop-Testing Machine.

The drop-testing machine shall have a tup of 2,000 lbs. weight, the striking face of which shall have a radius of not more than 5 ins., and the test rail shall be placed head upward on solid supports 3 ft. apart. The anvil block shall weigh at least 20,000 lbs., and the supports shall be part of, or firmly secured to, the anvil. The report of the drop test shall state the atmospheric temperature at the time the test was made. The temperature of the test pieces, when tested, shall be not less than 60° F. or greater than 120° F. The testing shall proceed concurrently with the operation of the mill.

Weight and Section.

5. Unless otherwise specified, the section of rail shall be the American standard, recommended by the American Society of

Civil Engineers, and shall conform, as accurately as possible, to the templet furnished by the railroad company, consistent with Paragraph 6, relative to specified weight. A variation in height of $\frac{1}{64}$ in. less, or $\frac{1}{32}$ in. greater than the specified height, and $\frac{1}{16}$ in. in width will be permitted.

6. The weight of the rails will be maintained as nearly as possible, after complying with Paragraph 5, to that specified in the contract. A variation of one-half of 1 per cent. for an entire order will be allowed. Rails shall be accepted and paid for according to actual weights.

Length. 7. The standard length of rails shall be 30 or 33 feet. Ten per cent. of the entire order will be accepted in shorter lengths, varying by even feet down to 24 feet. A variation of $\frac{1}{4}$ in. in length from that specified will be allowed.

Both ends of all short-length No. 1 rails shall be painted green.

8. Circular holes for splice bolts shall be drilled in accordance with the specifications of the purchaser. The holes shall accurately conform to the drawing and dimensions furnished, and must be free from burrs.

Finish. 9. Care must be taken in hot-straightening the rails, and it must result in their being left in such a condition that they shall not vary throughout their entire length more than 5 ins. from a straight line in any direction when delivered to the cold-straightening presses. Those which vary beyond that amount, or have short kinks, shall be classed as second quality rails and be so stamped. The distance between supports of rails in the gagging press shall not be less than 42 ins. Rails shall be straight in line and surface when finished—the straightening being done while cold—smooth on head, sawed square at ends, variations to be not more than $\frac{1}{32}$ in., and, prior to shipment, shall have the burr occasioned by the saw cutting removed and the ends made clean. No. 1 rails shall be free from injurious defects and flaws of all kinds.

Branding. 10. The name of the maker, the weight of the rail, and the month and year of manufacture shall be rolled in raised letters on the side of the web, and the number of the heat shall be so stamped on each rail as not to be covered by the splice bars. For rails weighing 70 lbs. per yard or over, a letter shall be stamped on the side of the web to indicate the portion of the ingot from which the rail was rolled.

11. No. 2 rails will be accepted to at least 5 per cent. of the whole order. Rails that possess any injurious defects, or which for any other cause are not suitable for first quality, or No. 1 rails, shall be considered as No. 2 rails; provided, however, that rails which contain any physical defects which impair their strength shall be rejected. The ends of all No. 2 rails shall be painted white in order to distinguish them. Rails rejected under the drop test will not be accepted as No. 2 rails. **No. 2 Rails.**

12. The manufacturer shall furnish the inspector, daily, with carbon determinations of each blow, and a complete chemical analysis every 24 hours, representing the average of the other elements contained in the steel for each day and night turn. Analyses shall be made on drillings taken from small test ingots, the drillings being taken at a distance of not less than $\frac{1}{4}$ in. beneath the surface of said test ingots. On request of the inspector the manufacturer shall furnish drillings for check analysis. **Inspection.**

The inspector representing the purchaser shall have free entry to the works of the manufacturer at all times while his contract is being executed, and shall have all reasonable facilities afforded him by the manufacturer to satisfy him that the rails are being made in accordance with the terms of the contract. All tests and inspection shall be made at the place of manufacture prior to shipment, and shall be so conducted as not to unnecessarily interfere with the operation of the mill.

AMERICAN SOCIETY FOR TESTING MATERIALS

PHILADELPHIA, PA., U. S. A.

AFFILIATED WITH THE

INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.

STANDARD SPECIFICATIONS FOR OPEN-HEARTH STEEL RAILS.

ADOPTED AUGUST 16, 1909

Process of Manufacture.

1. (*a*) The entire process of manufacture and testing shall be in accordance with the best current practice, and special care shall be taken to conform to the following instructions:

(*b*) Ingots shall be kept in a vertical position in the pit heating furnaces until ready to be rolled or until the metal in the interior has time to solidify.

(*c*) No bled ingots shall be used.

(*d*) There shall be sheared from the end of the blooms formed from the top of the ingots not less than *x* per cent.,* and if, from any cause, the steel does not then appear to be solid, the shearing shall continue until it does.

Chemical Composition.

2. Rails of the various weights per yard specified below shall conform to the following limits in chemical composition:

	50 to 60 lbs. Per cent.	61 to 70 lbs. Per cent.	71 to 80 lbs. Per cent.	81 to 90 lbs. Per cent.	91 to 100 lbs. Per cent.
Carbon	0.46-0.59	0.46-0.59	0.52-0.65	0.59-0.72	0.62-0.75
Phosphorus, not over	0.04	0.04	0.04	0.04	0.04
Silicon, not over	0.20	0.20	0.20	0.20	0.20
Manganese	0.60-0.90	0.60-0.90	0.60-0.90	0.60-0.90	0.60-0.90

*The percentage of minimum discard in any case to be subject to agreement, and it should be recognized that the higher this percentage the greater will be the cost.

For each decrease of 0.003 per cent. in phosphorus down to 0.03 per cent. phosphorus, an increase of 0.01 per cent. carbon will be accepted.

3. The number of passes and speed of train shall be so regulated that on leaving the rolls at the final pass, the temperature of rails of sections 75 lbs. per yard and heavier will not exceed that which requires a shrinkage allowance at the hot saws of $6\frac{7}{16}$ ins. for a 33-ft. 75-lb. rail, with an increase of $\frac{1}{16}$ in. for each increase of 5 lbs. in the weight of the section. **Shrinkage.**

No artificial means of cooling the steel shall be used after the rails leave the rolls, nor shall they be held before sawing for the purpose of reducing their temperature.

4. One drop test may be made on a piece of rail not less than 4 ft. and not more than 6 ft. long, selected from each heat of steel. **Drop Test.**

The rails shall be placed head upward on the supports and the various sections shall be subjected to the following impact tests under a free falling weight:

Weights of rail per yard.	Height of drop in feet.
50 to 60 lbs.	15
61 to 70 lbs.	16
71 to 80 lbs.	16
81 to 90 lbs.	17
91 to 100 lbs.	18

If any rail breaks when subjected to the drop test, two additional tests will be made of other rails from the same heat of steel, and if either of these latter tests fail, all the rails of the heat which they represent will be rejected; but if both of these additional test pieces meet the requirements all the rails of the heat which they represent will be accepted.

The drop-testing machine shall have a tup of 2,000 lbs. weight, the striking face of which shall have a radius of not more than 5 ins., and the test rail shall be placed head upward on solid supports 3 ft. apart. The anvil block shall weigh at least 20,000 lbs., and the supports shall be part of, or firmly secured to, the anvil. The report of the drop test shall state the atmospheric temperature at the time the test was made. The temperature of the test pieces, when tested, shall be not less than 60° F. or greater than 120° F. The testing shall proceed concurrently with the operation of the mill. **Drop-Testing Machine.**

Weight and Section.

5. Unless otherwise specified, the section of rail shall be the American standard, recommended by the American Society of Civil Engineers, and shall conform, as accurately as possible, to the templet furnished by the railroad company, consistent with Paragraph 6, relative to specified weight. A variation in height of $\frac{1}{64}$ in. less, or $\frac{1}{32}$ in. greater than the specified height, and $\frac{1}{16}$ in. in width will be permitted.

6. The weight of the rails will be maintained as nearly as possible, after complying with Paragraph 5, to that specified in the contract. A variation of one-half of 1 per cent. for an entire order will be allowed. Rails shall be accepted and paid for according to actual weights.

Length.

7. The standard length of rails shall be 30 or 33 feet. Ten per cent. of the entire order will be accepted in shorter lengths, varying by even feet down to 24 feet. A variation of $\frac{1}{4}$ in. in length from that specified will be allowed.

Both ends of all short-length No. 1 rails shall be painted green.

8. Circular holes for splice bolts shall be drilled in accordance with the specifications of the purchaser. The holes shall accurately conform to the drawing and dimensions furnished, and must be free from burrs.

Finish.

9. Care must be taken in hot-straightening the rails, and it must result in their being left in such a condition that they shall not vary throughout their entire length more than 5 ins. from a straight line in any direction when delivered to the cold-straightening presses. Those which vary beyond that amount, or have short kinks, shall be classed as second quality rails and be so stamped. The distance between supports of rails in the gagging press shall not be less than 42 ins. Rails shall be straight in line and surface when finished—the straightening being done while cold—smooth on head, sawed square at ends, variations to be not more than $\frac{1}{32}$ in., and, prior to shipment, shall have the burr occasioned by the saw cutting removed and the ends made clean. No. 1 rails shall be free from injurious defects and flaws of all kinds.

Branding.

10. The name of the maker, the weight of the rail, and the month and year of manufacture shall be rolled in raised letters on the side of the web, and the number of the heat and the letters O. H. (to designate the grade of steel) shall be so stamped on each

rail as not to be covered by the splice bars. For rails weighing 70 lbs. per yard or over, a letter shall be stamped on the side of the web to indicate the portion of the ingot from which the rail was rolled.

No. 2 Rails

11. No. 2 rails will be accepted to at least 5 per cent. of the whole order. Rails that possess any injurious defects, or which for any other cause are not suitable for first quality, or No. 1 rails, shall be considered as No. 2 rails; provided, however, that rails which contain any physical defects which impair their strength shall be rejected. The ends of all No. 2 rails shall be painted white in order to distinguish them. Rails rejected under the drop test will not be accepted as No. 2 rails.

Inspection.

12. The manufacturer shall furnish the inspector a chemical analysis of each heat of steel covering the elements specified. Analyses shall be made on drillings taken from small test ingots, the drillings being taken at a distance of not less than $\frac{1}{4}$ in. beneath the surface of said test ingots. On request of the inspector the manufacturer shall furnish drillings for check analysis.

The inspector representing the purchaser shall have free entry to the works of the manufacturer at all times while his contract is being executed, and shall have all reasonable facilities afforded him by the manufacturer to satisfy him that the rails are being made in accordance with the terms of the contract. All tests and inspection shall be made at the place of manufacture prior to shipment, and shall be so conducted as not to unnecessarily interfere with the operation of the mill.

AMERICAN SOCIETY FOR TESTING MATERIALS

PHILADELPHIA, PA., U. S. A.

AFFILIATED WITH THE

INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.

STANDARD SPECIFICATIONS

FOR

OPEN-HEARTH STEEL GIRDER AND HIGH TEE RAILS.

ADOPTED JUNE 1, 1912.

I. MANUFACTURE.

Process. 1. The steel shall be made by the open-hearth process. The entire process of manufacture and testing shall accord with the best current practice.

Bled Ingots 2. Bled ingots, and ingots or blooms which show the effects of injurious treatment, shall not be used.

Discard. 3. A sufficient discard from the top of each ingot shall be made at any stage of the manufacture to obtain sound rails. When finished rails show piping, they may be cut to shorter lengths until all evidence of this is removed.

II. CHEMICAL PROPERTIES AND TESTS.

Chemical Composition. 4. The steel shall conform to either of the following requirements as to chemical composition, as specified in the order:

	CLASS A.	CLASS B.
Carbon, per cent	0.60 – 0.75	0.70 – 0.85
Manganese, per cent	0.60 – 0.90	0.60 – 0.90
Silicon, per cent	not over 0.20	not over 0.20
Phosphorus, per cent	" " 0.04	" " 0.04

5. To determine whether the material conforms to the requirements specified in Section 4, an analysis shall be made by the manufacturer from a test ingot taken during the pouring of each melt. Drillings for analysis shall be taken not less than $\frac{1}{8}$ in. beneath the surface of the test ingot. A copy of this analysis shall be given to the purchaser or his representative. **Ladle Analyses.**

6. A check analysis may be made from time to time by the purchaser from a test ingot or drillings therefrom furnished by the manufacturer. **Check Analyses.**

III. PHYSICAL PROPERTIES AND TESTS.

7. (*a*) The test specimen shall be tested on a drop-test machine of the type recommended by the American Railway Engineering Association. The specimen shall be placed head upwards on the supports of the machine, and shall not break when tested with one blow in accordance with the following conditions: **Drop Tests.**

Weight and Height of Rail.	Temperature of Specimen, deg. Fahr.	Distance between Supports, ft.	Weight of Tup, lb.	Height of Drop.	
				Class A	Class B
Rails weighing over 100 lb. per yd. and over 7 in. in depth.....	60 - 120	3	2000	15	12
Rails weighing 100 lb. or less per yd., or 7 in. or less in depth.....	60 - 120	3	2000	13	10

(*b*) The atmospheric temperature at the time of testing shall be recorded in the test report.

(*c*) The testing shall proceed concurrently with the operation of the works.

8. (*a*) Three rails, each from the top of one of three ingots from each melt, shall be selected by the inspector, and a test specimen shall be taken from each of two of these. **Test Specimens.**

(*b*) Drop test specimens shall not be less than 4 nor more than 6 ft. in length.

9. Two drop tests shall be made from each melt. **Number of Tests.**

10. If the result of the drop test on only one of the two specimens representing the rails in a melt, does not conform to the requirements specified in Section 7, a retest on a specimen **Retests.**

from the third rail selected shall be made and this shall govern the acceptance or rejection of the rails from that melt.

IV. STANDARD SECTIONS, LENGTHS, AND WEIGHTS.

Section. 11. (*a*) The cold templet of the manufacturer shall conform to the specified section as shown in detail on the drawing of the purchaser, and shall at all times be maintained perfect.

(*b*) The section of the rail shall conform as accurately as possible to the templet, and within the following tolerances:

(1) The height shall not vary more than $\frac{1}{64}$ in. under nor more than $\frac{1}{32}$ in. over that specified.

(2) The over-all width of head and tram shall not vary more than $\frac{1}{8}$ in. from that specified. Any variation which would affect the gage line more than $\frac{1}{32}$ in. will not be allowed.

(3) The width of base shall not vary more than $\frac{1}{8}$ in. under that specified for widths less than $6\frac{1}{2}$ in.; $\frac{3}{16}$ in. under for a width of $6\frac{1}{2}$ in.; and $\frac{1}{4}$ in. under for a width of 7 in.

(4) Any variation which would affect the fit of the splice bars will not be allowed.

(5) The base of the rail shall be at right angles to the web; and the convexity shall not exceed $\frac{1}{32}$ in.

(*c*) When necessary on account of the type of track construction, and notice to that effect has been given to the manufacturer, special care shall be taken to maintain the proper position of the gage line with respect to the outer edge of the base.

Length. 12. (*a*) Unless otherwise specified, the lengths of rails at a temperature of 60° F. shall be 60 and 62 ft. for those sections in which the weight per yard will permit.

(*b*) The lengths shall not vary more than $\frac{1}{4}$ in. from those specified.

(*c*) Shorter lengths, varying by even feet down to 40 ft., will be accepted to the extent of 10 per cent by weight of the entire order.

Weight. 13. (*a*) The weight of the rails per yard as specified in the order shall be maintained as nearly as possible after conforming to the requirements specified in Section 11.

(*b*) The total weight of an order shall not vary more than 0.5 per cent from that specified.

(*c*) Payments shall be based on actual weights.

V. WORKMANSHIP AND FINISH.

Straightening

14. (*a*) Rails on the hot beds shall be protected from water or snow, and shall be carefully manipulated to minimize cold straightening.

(*b*) The distance between the rail supports in the cold-straightening presses shall not be less than 42 in., except as may be necessary near the ends of the rails. The gag shall have rounded corners to avoid injury to the rails.

Drilling and Punching.

15. (*a*) Circular holes for joint bolts, bonds, and tie rods shall be drilled to conform to the drawings and dimensions furnished by the purchaser.

(*b*) In Class A rails the tie-rod holes may be punched.

Milling.

16. The ends shall be milled square laterally and vertically, but the base may be undercut $\frac{1}{32}$ in.

Finish.

17. (*a*) Rails shall be smooth on the head, straight in line and surface without any twists, waves, or kinks, particular attention being given to having the ends without kinks or drop.

(*b*) All burrs or flow caused by drilling or sawing shall be carefully removed.

(*c*) Rails shall be free from gag marks and other injurious defects of cold-straightening.

VI. CLASSIFICATION OF RAILS.

No. 1 Rails.

18. Rails which are free from injurious defects and flaws of all kinds shall be classed as No. 1 Rails.

No. 2 Rails.

19. (*a*) Rails which are rough on the head or which by reason of surface or other imperfections are not classed as No. 1 rails, shall be classed as No. 2 rails; provided they do not, in the judgment of the inspector, contain imperfections in such number and of such character as to render them unfit for No. 2 rail uses, and provided they conform to the requirements specified in Section 11.

(*b*) Rails which have flaws in the head exceeding $\frac{1}{4}$ in. in depth, or in the base exceeding $\frac{1}{2}$ in. in depth, shall not be classed as No. 2 rails.

(*c*) No. 2 rails will be accepted to the extent of 10 per cent by weight of the entire order.

VII. MARKING AND LOADING.

Marking.

20. (*a*) The name or brand of the manufacturer, the year and month of manufacture, the letters "O. H.," the weight of the rail, and the section number, shall be legibly rolled in raised letters and figures on the web. The melt number shall be legibly stamped on each rail where it will not be covered subsequently by the joint plates.

(*b*) Both ends of all short-length No. 1 rails shall be painted green.

Both ends of all No. 2 rails shall be painted white and shall have two heavy center-punch marks on the web at each end at such a distance from the end that they will not be covered subsequently by the joint plates.

Loading.

21. (*a*) Rails shall be loaded in the presence of the inspector, and shall be handled in such a manner as not to bruise the flanges or cause other injuries.

(*b*) Rails of each class shall be placed together in loading.

(*c*) Rails shall be paired as to length before shipment.

VIII. INSPECTION.

Inspection.

22. The inspector representing the purchaser shall have free entry, at all times while work on the contract of the purchaser is being performed, to all parts of the manufacturer's works which concern the manufacture of the material ordered. The manufacturer shall afford the inspector, free of cost, all reasonable facilities to satisfy him that the material is being furnished in accordance with these specifications. All tests and inspection shall be made at the place of manufacture prior to shipment, and shall be so conducted as not to interfere unnecessarily with the operation of the works.

AMERICAN SOCIETY FOR TESTING MATERIALS

PHILADELPHIA, PA., U. S. A.

AFFILIATED WITH THE

INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.

STANDARD SPECIFICATIONS FOR STEEL SPLICE BARS.

ADOPTED JUNE 1, 1912.

I. MANUFACTURE.

Process.

1. The steel may be made by the Bessemer or the open-hearth process.

II. CHEMICAL PROPERTIES AND TESTS.

Chemical Composition.

2. The steel shall conform to the following requirement as to chemical composition:

Phosphorus	not over 0.10 per cent

Ladle Analyses.

3. To determine whether the material conforms to the requirement specified in Section 2, an analysis shall be made by the manufacturer from a test ingot.

III. PHYSICAL PROPERTIES AND TESTS.

Tension Tests.

4. (*a*) The steel shall conform to the following requirements as to tensile properties:

Tensile strength, lb. per sq. in.	55 000 – 65 000
Yield point, min., " "	0.5 tens. str.
Elongation in 8 in., min., per cent	25

(*b*) The yield point shall be determined by the drop of the beam of the testing machine.

Bend Tests. 5. (*a*) The test specimen shall bend cold through 180 deg. flat on itself without fracture on the outside of the bent portion.

(*b*) Bend tests may be made by pressure or by blows.

Test Specimens. 6. (*a*) Tension test specimens shall be taken from the finished rolled product, and shall be of 8-in. gage length.

(*b*) Bend test specimens may be taken from the head of the splice bar; or bend tests may be made on an unpunched splice bar, flattened if necessary.

Number of Tests. 7. (*a*) One tension and one bend test shall be made from each melt.

(*b*) If any test specimen develops flaws, or if a tension test specimen breaks outside the middle third of the gage length, it may be discarded and another specimen substituted.

IV. WORKMANSHIP AND FINISH.

Workmanship. 8. The splice bars shall be true to templet, sheared accurately to length, and shall perfectly fit the rails for which they are intended. The punching and notching shall conform to the dimensions on the drawings of the purchaser.

Finish. 9. The finished splice bars shall be free from injurious seams, slivers, flaws, and other defects, and shall have a workmanlike finish.

V. MARKING.

Marking. 10. The name of the manufacturer and the year of manufacture shall be rolled in raised letters and figures on the side of the splice bar.

VI. INSPECTION.

Inspection. 11. The inspector representing the purchaser shall have free entry, at all times while work on the contract of the purchaser is being performed, to all parts of the manufacturer's works which concern the manufacture of the material ordered. The manufacturer shall afford the inspector, free of cost, all reasonable facilities to satisfy him that the material is being furnished in accordance with these specifications. All tests and inspection shall be made at the place of manufacture prior to shipment, and shall be so conducted as not to interfere unnecessarily with the operation of the works.

AMERICAN SOCIETY FOR TESTING MATERIALS

PHILADELPHIA, PA., U. S. A.

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INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.

STANDARD SPECIFICATIONS FOR STRUCTURAL STEEL FOR BRIDGES.

ADOPTED AUGUST 16, 1909.

I. MANUFACTURE.

1. The steel shall be made by the open-hearth process. **Process.**

II. CHEMICAL PROPERTIES AND TESTS.

2. The steel shall conform to the following requirements as to chemical composition: **Chemical Composition.**

CHEMICAL COMPOSITION.

Elements Considered.	Structural Steel.	Rivet Steel.	Steel Castings.
Phosphorus, max., per cent { Acid	0.06	0.04	0.08
Phosphorus, max., per cent { Basic	0.04	0.04	0.05
Sulphur, max., per cent	0.05	0.04	0.05

3. An analysis shall be made by the manufacturer from a test ingot taken during the pouring of each melt, to determine the percentages of carbon, manganese, phosphorus and sulphur. A copy of this analysis shall be given to the purchaser or his representative. **Ladle Analyses.**

4. A check analysis shall be made from finished material representing each melt, if called for by the purchaser, in which case an excess of 25 per cent above the requirements specified in Section 2 shall be allowed. **Check Analyses.**

III. PHYSICAL PROPERTIES AND TESTS.

Tension Tests.

5. The steel shall conform to the following requirements as to tensile properties:

TENSILE PROPERTIES.

Properties Considered.	Structural Steel.	Rivet Steel.	Steel Castings.
Tensile strength, lb. per sq. in.	Desired 60 000[1]	Desired 50 000[1]	65 000 min.
Elongation in 8 in., min., per cent.	$\frac{1\,500\,000[2]}{\text{Tens. str.}}$	$\frac{1\,500\,000}{\text{Tens. str.}}$	.....
Elongation in 2 in., min., per cent.	22	.....	18

[1] See Section 7.
[2] See Section 8.

Yield Point.

6. The yield point, as determined by the drop of the beam of the testing machine, shall be recorded in the test reports.

Permissible Variations in Tensile Strength.

7. The tensile strength of structural and rivet steel may vary 4000 lb. per sq. in. from that specified in Section 5.

Modifications in Elongation.

8. (*a*) For material over $\frac{3}{4}$ in. in thickness, a deduction of 1 from the percentage of elongation in 8 in. specified in Section 5 for structural steel shall be made for each increase of $\frac{1}{8}$ in. in thickness above $\frac{3}{4}$ in.

(*b*) For material under $\frac{5}{16}$ in. in thickness, a deduction of 2.5 from the percentage of elongation in 8 in. specified in Section 5 for structural steel shall be made for each decrease of $\frac{1}{16}$ in. in thickness below $\frac{5}{16}$ in.

Character of Fracture.

9. All broken tension test specimens of structural and rivet steel shall show a silky fracture; and of steel castings, a silky or fine granular fracture.

Bend Tests.

10. (*a*) The test specimen for structural steel shall bend cold through 180 deg. without fracture on the outside of the bent portion, as follows: For material under 1 in. in thickness, flat on itself; and for material 1 in. or over in thickness, around a pin the diameter of which is equal to twice the thickness of the specimen.

(*b*) A rivet rod shall bend cold through 180 deg. flat on itself without fracture on the outside of the bent portion. When nicked and bent around a pin the diameter of which is equal to that of the rivet rod, it shall break gradually with a fine, silky, uniform fracture.

(*c*) The test specimen for steel castings shall bend cold through 90 deg. around a pin the diameter of which is equal to 3 times the thickness of the specimen, without fracture on the outside of the bent portion.

(*d*) Bend tests may be made by pressure or by blows.

Tests of Angles.

11. Angles $\frac{3}{4}$ in. or under in thickness shall open flat, and angles $\frac{1}{2}$ in. or under in thickness shall bend shut, cold, under blows of a hammer without fracture. This test shall be made only when required by the inspector.

Test Specimens.

12. (*a*) Tension and bend test specimens for plates, shapes, and bars shall be taken from the finished product, and shall be of the full thickness of material as rolled.

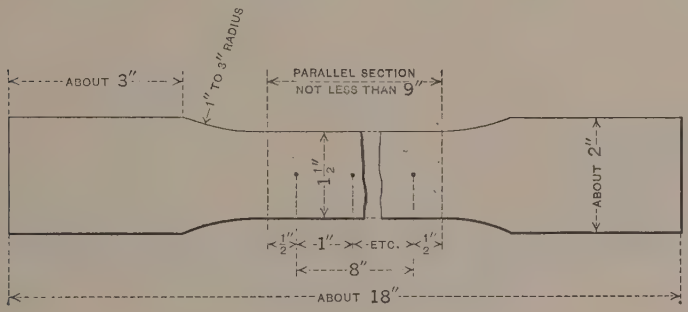

FIG. 1.

Tension test specimens may be of the form and dimensions shown in Fig. 1; or with both edges parallel; or they may be turned to a diameter of $\frac{3}{4}$ in. for a length of at least 9 in., with enlarged ends.

Bend test specimens for eye bars shall be of the full-size section as rolled. The sheared edges of bend test specimens shall be milled or planed.

(*b*) Rivet rods shall be tested as rolled.

(*c*) Tension and bend test specimens for pins and rollers shall be taken from the finished rolled or forged bar. The axis of the specimen shall be 1 in. from the surface of the bar, and shall be parallel to the axis of the bar.

Tension test specimens shall be of the form and dimensions shown in Fig. 2.

Bend test specimens shall be 1 by $\frac{1}{2}$ in. in section.

(*d*) Tension and bend test specimens for steel castings shall be taken cold from test bars attached to the castings, or from the sink-heads if they are of sufficient size. All test bars or sink heads so used shall be annealed with the castings.

Tension test specimens shall be of the form and dimensions shown in Fig. 2.

Bend test specimens shall be 1 by $\frac{1}{2}$ in. in section.

Annealed Specimens.

13. (*a*) Material which is to be used without annealing or further treatment shall be tested as rolled or forged.

(*b*) Tension test specimens for material which is to be annealed or otherwise treated before use, shall be cut from properly annealed or similarly treated short lengths of the full section of the piece.

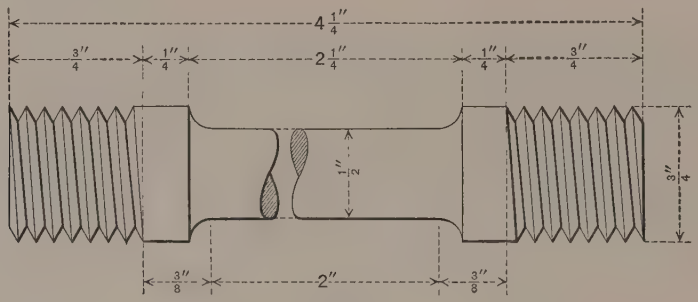

FIG. 2.

Number of Tests.

14. (*a*) At least one tension and one bend test for structural and rivet steel shall be made from each melt. If material from one melt differs $\frac{3}{8}$ in. or more in thickness, tests shall be made from both the thickest and the thinnest material rolled.

(*b*) The number of tension and bend tests for steel castings will depend on the character and importance of the castings.

Retests.

15. If the tensile strength of structural and rivet steel varies more than 4000 lb. per sq. in. from that specified in Section 5, a retest on the same gage may be made, at the option of of the inspector, and this shall not vary more than 5000 lb. per sq. in. from that specified.

IV. PERMISSIBLE VARIATIONS IN WEIGHT AND GAGE.

Permissible Variations

16. The cross-section or weight of each piece of steel shall not vary more than 2.5 per cent from that specified; except

in the case of sheared plates, which shall be covered by the following permissible variations to apply to single plates:

(*a*) *When Ordered to Weight.*—For plates $12\frac{1}{2}$ lb. per sq. ft. or over:

Under 100 in. in width, 2.5 per cent above or below the specified weight;

100 in. in width and over, 5 per cent above or below the specified weight.

For plates under $12\frac{1}{2}$ lb. per sq. ft.:

Under 75 in. in width, 2.5 per cent above or below the specified weight;

75 to 100 in. in width, 5 per cent above or 3 per cent below the specified weight;

100 in. in width and over, 10 per cent above or 3 per cent below the specified weight.

(*b*) *When Ordered to Gage.*—The thickness of each plate shall not vary more than 0.01 in. under that ordered.

An excess over the nominal weight corresponding to the dimensions on the order shall be allowed for each plate, if not more than that shown in the following table, one cubic inch of rolled steel being assumed to weigh 0.2833 lb.:

Thickness Ordered, in.	Nominal Weight, lb. per sq. ft.	Allowable Excess (expressed as percentage of Nominal Weight). For Width of Plate as follows:						
		Under 50 in.	50 in. to 70 in.	70 in. and over	Under 75 in.	75 in. to 100 in.	100 in. to 115 in.	115 in. and over.
$\frac{1}{8}$ to $\frac{5}{32}$	5.10 to 6.37	10	15	20	..	..	..	..
$\frac{5}{32}$ " $\frac{3}{16}$	6.37 " 7.65	8.5	12.5	17	..	..	..	..
$\frac{3}{16}$ " $\frac{1}{4}$	7.65 " 10.20	7	10	15	..	..	..	..
$\frac{1}{4}$	10.20	..	..	..	10	14	18	..
$\frac{5}{16}$	12.75	..	..	..	8	12	16	..
$\frac{3}{8}$	15.30	..	..	..	7	10	13	17
$\frac{7}{16}$	17.85	..	..	..	6	8	10	13
$\frac{1}{2}$	20.40	..	..	..	5	7	9	12
$\frac{9}{16}$	22.95	..	..	..	4.5	6.5	8.5	11
$\frac{5}{8}$	25.50	..	..	..	4	6	8	10
Over $\frac{5}{8}$	..	..	..	..	3.5	5	6.5	9

V. FINISH.

Finish. 17. The finished material shall be free from injurious seams, slivers, flaws, and other defects, and shall have a workmanlike finish. Plates 36 in. in width and under shall have rolled edges.

VI. MARKING.

Marking. 18. The name of the manufacturer and the melt number shall be legibly stamped or rolled on all finished material, except that each pin and roller shall be stamped on the end. Rivet and lattice steel and other small pieces may be shipped in securely fastened bundles, with the above marks legibly stamped on an attached metal tag.

VII. INSPECTION AND REJECTION.

Inspection. 19. (*a*) The purchaser shall be furnished complete copies of mill orders, and no material shall be rolled, nor work done, before the purchaser has been notified where the orders have been placed, so that he may arrange for the inspection.

(*b*) The inspector representing the purchaser shall have free entry, at all times while work on the contract of the purchaser is being performed, to all parts of the manufacturer's works which concern the manufacture of the material ordered. The manufacturer shall afford the inspector, free of cost, all reasonable facilities to satisfy him that the material is being furnished in accordance with these specifications. All tests and inspection shall be made at the place of manufacture prior to shipment, and shall be so conducted as not to interfere unnecessarily with the operation of the works.

Rejection. 20. Material which, subsequent to the above tests at the mills and its acceptance there, develops weak spots, brittleness, cracks or other imperfections, or is found to have injurious defects, will be rejected at the shop and shall be replaced by the manufacturer at his own cost.

AMERICAN SOCIETY FOR TESTING MATERIALS

PHILADELPHIA, PA., U. S. A.

AFFILIATED WITH THE

INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.

STANDARD SPECIFICATIONS FOR STRUCTURAL NICKEL STEEL.

ADOPTED JUNE 1, 1912.

I. MANUFACTURE.

1. The steel shall be made by the open-hearth process. **Process.**

2. A discard of at least 25 per cent shall be made from the top of each ingot intended for eye bars. If necessary, the shearing shall be continued until sound metal is found. **Discard.**

II. CHEMICAL PROPERTIES AND TESTS.

3. The steel shall conform to the following requirements as to chemical composition: **Chemical Composition.**

CHEMICAL COMPOSITION.

Elements Considered.	Rivets.	Plates and Shapes.	Bars and Rollers, Unannealed.	Bars and Pins, Annealed.
Carbon, max. per cent	0.30	0.45	0.45	0.45
Manganese, max. per cent	0.60	0.70	0.70	0.70
Phosphorus, max. per cent { Acid	0.04	0.05	0.05	0.05
Phosphorus, max. per cent { Basic	0.03	0.04	0.04	0.04
Sulphur, max. per cent	0.04	0.04	0.04	0.04
Nickel, min. per cent	3.25	3.25	3.25	3.25

Ladle Analyses.

4. To determine whether the material conforms to the requirements specified in Section 3, an analysis shall be made by the manufacturer from a test ingot taken during the pouring of each melt. A copy of this analysis shall be given to the purchaser or his representative.

Check Analyses.

5. A check analysis may be made by the purchaser from finished material representing each melt, and this analysis shall conform to the requirements specified in Section 3.

III. PHYSICAL PROPERTIES AND TESTS.

Tension Tests.

6. (*a*) The steel shall conform to the following requirements as to tensile properties:

TENSILE PROPERTIES FROM SPECIMEN TESTS.

Properties Considered.	Rivets.	Plates and Shapes.	Bars and Rollers,[c] Unannealed.	Bars [a] and Pins,[c] Annealed.
Tensile strength, lb. per sq. in.	70 000–80 000	85 000–100 000	95 000–110 000	90 000–105 000
Yield point, min., lb. per sq. in.	45 000	50 000	55 000	52 000
Elongation in 8 in., min., per cent	1 500 000 Tens. str.	1 500 000 [b] Tens. str.	1 500 000 [b] Tens. str.	20
Elongation in 2 in., min., per cent	.....	.....	16	20
Reduction of area, min., per cent	40	25	25	35

a Tests of annealed specimens of bars shall be made for information only.
b See Section 7.
c Elongation shall be measured in 2 in.

(*b*) The yield point shall be determined by the drop of the beam of the testing machine.

Modifications in Elongation.

7. For plates, shapes, and unannealed bars over 1 in. in thickness, a deduction of 1 from the percentage of elongation specified in Section 6 shall be made for each increase of $\frac{1}{8}$ in. in thickness above 1 in., to a minimum of 14 per cent.

Character of Fracture.

8. All broken tension test specimens shall show either a silky or a very fine granular fracture, of uniform color, and free from coarse crystals.

Bend Tests.

9. (*a*) The test specimen for plates, shapes and bars, shall bend cold through 180 deg. without fracture on the outside of the bent portion, as follows: For material $\frac{3}{4}$ in. or under in

thickness, around a pin the diameter of which is equal to the thickness of the specimen; and for material over $\frac{3}{4}$ in. in thickness, around a pin the diameter of which is equal to twice the thickness of the specimen.

(*b*) A rivet rod shall bend cold through 180 deg. flat on itself without fracture on the outside of the bent portion.

(*c*) The test specimen for pins and rollers shall bend cold through 180 deg. around a 1-in. pin, without fracture on the outside of the bent portion.

(*d*) Bend tests may be made by pressure or by blows.

Tests of Angles.

10. (*a*) Angles with 4-in. legs or under, and $\frac{1}{2}$ in. or under in thickness, shall open flat or bend shut, cold, under the blows of a hammer without fracture.

(*b*) Angles with legs over 4 in., or over $\frac{1}{2}$ in. in thickness.

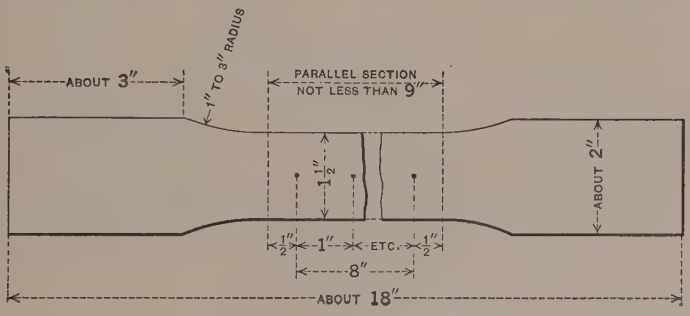

FIG. 1.

shall open to an angle of 150 deg., or close to an angle of 30 deg., cold, under the blows of a hammer without fracture.

Drift Tests.

11. Punched rivet holes pitched two diameters from a planed edge shall stand drifting until the diameter is enlarged 50 per cent, without cracking the metal.

Test Specimens.

12. (*a*) Tension and bend test specimens for plates, shapes and bars shall be taken from the finished product, and shall be of the full thickness of material as rolled.

Tension test specimens may be of the form and dimensions shown in Fig. 1; or with both edges parallel; or they may be turned to a diameter of $\frac{3}{4}$ in. for a length of at least 9 in., with enlarged ends.

Bend test specimens shall not be less than 2 in. in width.

(*b*) Rivet rods shall be tested as rolled.

(*c*) Tension and bend test specimens for pins and rollers shall be taken from the finished rolled or forged bar. The axis of the specimen shall be 1 in. from the surface of the bar and shall be parallel to the axis of the bar. Test specimens for pins shall be taken after annealing.

Tension test specimens shall be of the form and dimensions shown in Fig. 2.

Bend test specimens shall be 2 by $\frac{1}{2}$ in. in section.

Number of Tests.

13. At least one tension and one bend test shall be made from each melt. If material from one melt differs $\frac{3}{8}$ in. or over in thickness, tests shall be made from both the thickest and the thinnest material rolled. No material under $\frac{5}{16}$ in. in thickness will be used.

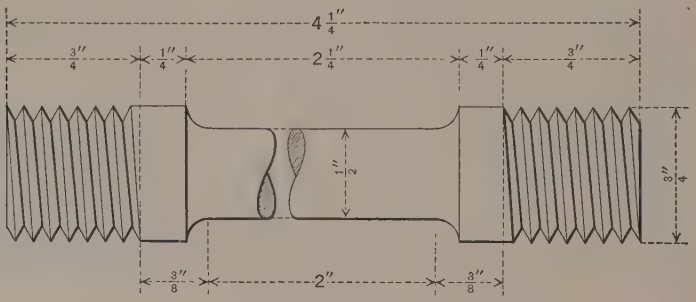

FIG. 2

IV. PERMISSIBLE VARIATIONS IN WEIGHT AND GAGE.

Permissible Variations.

14. The cross-section or weight of each piece of steel shall not vary more than 2.5 per cent from that specified; except in the case of sheared plates, which shall be covered by the following permissible variations to apply to single plates:

(*a*) *When Ordered to Weight.*—For plates $12\frac{1}{2}$ lb. per sq. ft or over:

Under 100 in. in width, 2.5 per cent above or below the specified weight;

100 in. in width and over, 5 per cent above or below the specified weight.

(*b*) *When Ordered to Gage.*—The thickness of each plate shall not vary more than 0.01 in. below that ordered.

An excess over the nominal weight corresponding to the dimensions on the order shall be allowed for each plate, if not more than that shown in the following table, one cubic inch of rolled steel being assumed to weigh 0.2833 lb.:

Thickness Ordered, in.	Nominal Weight, lb. per sq. ft.	Allowable Excess (expressed as percentage of Nominal Weight). For Width of Plate as follows:			
		Under 75 in.	75 in. to 100 in.	100 in. to 115 in.	115 in. and over.
$\frac{5}{16}$	12.75	8	12	16	.....
$\frac{3}{8}$	15.30	7	10	13	17
$\frac{7}{16}$	17.85	6	8	10	13
$\frac{1}{2}$	20.40	5	7	9	12
$\frac{9}{16}$	22.95	4.5	6.5	8.5	11
$\frac{5}{8}$	25.50	4	6	8	10
Over $\frac{5}{8}$	....	3.5	5	6.5	9

V. FINISH.

15. The finished material shall be free from injurious seams, slivers, flaws, and other defects, and shall have a workmanlike finish. **Finish.**

VI. MARKING.

16. The name of the manufacturer and the melt number shall be legibly stamped or rolled on all finished material, except that each pin and roller shall be stamped on the end. Rivet and lattice steel and other small pieces shall be shipped in securely fastened bundles, with the above marks legibly stamped on an attached metal tag. **Marking.**

VII. INSPECTION.

17. The inspector representing the purchaser shall have free entry, at all times while work on the contract of the purchaser is being performed, to all parts of the manufacturer's works which concern the manufacture of the material ordered. The manufacturer shall afford the inspector, free of cost, all reasonable facilities to satisfy him that the material is being **Inspection.**

furnished in accordance with these specifications. All tests and inspection shall be made at the place of manufacture prior to shipment, and shall be so conducted as not to interfere unnecessarily with the operation of the works.

VIII. FULL-SIZE TESTS.

Tests of Eye Bars.

18. (*a*) Full-size tests of annealed eye bars shall conform to the following requirements as to tensile properties:

Tensile strength, lb. per sq. in.....	85 000–100 000
Yield point, min., " "	48 000
Elongation in 18 ft., min., per cent.....	10
Reduction of area, " "	30

(*b*) The yield point shall be determined by the halt of the gage of the testing machine.

AMERICAN SOCIETY FOR TESTING MATERIALS

PHILADELPHIA, PA., U. S. A.

AFFILIATED WITH THE

INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.

STANDARD SPECIFICATIONS

FOR

STRUCTURAL STEEL FOR BUILDINGS.

ADOPTED AUGUST 16, 1909.

I. MANUFACTURE.

Process.

1. (*a*) Structural steel, except as noted in Section 1(*b*), may be made by the Bessemer or the open-hearth process.

(*b*) Rivet steel, and steel for plates or angles over $\frac{3}{4}$ in. in thickness which are to be punched, shall be made by the open-hearth process.

II. CHEMICAL PROPERTIES AND TESTS.

Chemical Composition.

2. The steel shall conform to the following requirements as to chemical composition:

		Structural Steel.	Rivet Steel.
Phosphorus	Bessemer	not over 0.10 per cent	. . . . .
	Open-hearth . . .	" 0.06 "	not over 0.06 per cent

Ladle Analyses.

3. To determine whether the material conforms to the requirements specified in Section 2, an analysis shall be made by the manufacturer from a test ingot taken during the pouring of each melt. A copy of this analysis shall be given to the purchaser or his representative.

III. PHYSICAL PROPERTIES AND TESTS.

Tension Tests.

4. (*a*) The steel shall conform to the following requirements as to tensile properties:

TENSILE PROPERTIES.

Properties Considered.	Structural Steel.	Rivet Steel.
Tensile strength, lb. per sq. in.	55 000 – 65 000	48 000 – 58 000
Yield point, min., lb. per sq. in.	0.5 tens. str.	0.5 tens. str.
Elongation in 8 in., min., per cent.	$\frac{1\,400\,000}{\text{Tens. str.}}$[1]	$\frac{1\,400\,000}{\text{Tens. str.}}$

[1] See Sections 5 and 6.

(*b*) The yield point shall be determined by the drop of the beam of the testing machine.

Elongation for Pins.

5. The percentage of elongation for pins shall be 5 less than that specified for structural steel in Section 4.

Modifications in Elongation.

6. (*a*) For material over $\frac{3}{4}$ in. in thickness, a deduction of 1 from the percentage of elongation specified in Section 4 shall be made for each increase of $\frac{1}{8}$ in. in thickness above $\frac{3}{4}$ in.

(*b*) For material under $\frac{5}{16}$ in. in thickness, a deduction of 2.5 from the percentage of elongation specified in Section 4 shall be made for each decrease of $\frac{1}{16}$ in. in thickness below $\frac{5}{16}$ in.

Character of Fracture.

7. All broken tension test specimens shall show a silky fracture.

Bend Tests.

8. (*a*) The test specimen for structural steel shall bend cold through 180 deg. around a pin the diameter of which is equal to the thickness of the specimen, without fracture on the outside of the bent portion.

(*b*) A rivet rod shall bend cold through 180 deg. flat on itself without fracture on the outside of the bent portion.

(*c*) Bend tests may be made by pressure or by blows.

Test Specimens.

9. (*a*) Tension and bend test specimens for structural steel shall be taken from the finished product, and shall be of full thickness of material as rolled.

Tension test specimens may be of the form and dimensions shown in Fig. 1; or with both edges parallel; or they may be turned to a diameter of $\frac{3}{4}$ in. for a length of at least 9 in., with enlarged ends.

Bend test specimens for material over $\frac{3}{4}$ in. in thickness may be 1 by $\frac{1}{2}$ in. in section. The sheared edges of specimens shall be milled or planed.

(*b*) Rivet rods and small rolled bars shall be tested as rolled.

(*c*) Tension test specimens for pins shall be taken from the finished rolled or forged bar. The axis of the specimen shall be 1 in. from the surface of the bar, and shall be parallel to the axis of the bar.

10. (*a*) Material which is to be used without annealing or further treatment shall be tested as rolled or forged. **Annealed Specimens.**

(*b*) Tension test specimens for material which is to be annealed or otherwise treated before use, shall be cut from properly annealed or similarly treated short lengths of the full section of the piece.

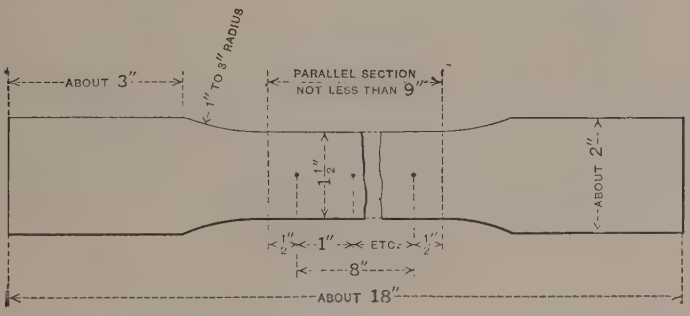

FIG. 1.

11. (*a*) At least one tension and one bend test shall be made from each melt. If material from one melt differs $\frac{3}{8}$ in. or more in thickness, tests shall be made from both the thickest and the thinnest material rolled. **Number of Tests.**

(*b*) If any test specimen develops flaws, or if a tension test specimen breaks outside the middle third of the gage length, it may be discarded and another specimen substituted.

12. If the results of the tension tests do not conform to the requirements specified in Section 4, retests may be made. **Retests.**

IV. PERMISSIBLE VARIATIONS IN WEIGHT AND GAGE.

13. The cross-section or weight of each piece of steel shall not vary more than 2.5 per cent from that specified; except in **Permissible Variations.**

the case of sheared plates, which shall be covered by the following permissible variations to apply to single plates:

(*a*) *When Ordered to Weight.*—For plates $12\frac{1}{2}$ lb. per sq. ft. or over:

Under 100 in. in width, 2.5 per cent above or below the specified weight;

100 in. in width and over, 5 per cent above or below the specified weight.

For plates under $12\frac{1}{2}$ lb. per sq. ft.:

Under 75 in. in width, 2.5 per cent above or below the specified weight;

75 to 100 in. in width, 5 per cent above or 3 per cent below the specified weight;

100 in. in width and over, 10 per cent above or 3 per cent below the specified weight.

(*b*) *When Ordered to Gage.*—The thickness of each plate shall not vary more than 0.01 in. below that ordered.

An excess over the nominal weight corresponding to the dimensions on the order shall be allowed for each plate, if not more than that shown in the following table, one cubic inch of rolled steel being assumed to weigh 0.2833 lb.:

Thickness Ordered, in.	Nominal Weight, lb. per sq. ft.	Allowable Excess (expressed as percentage of Nominal Weight). For Width of Plate as follows:						
		Under 50 in.	50 in. to 70 in.	70 in. and over.	Under 75 in.	75 in. to 100 in.	100 in. to 115 in.	115 in. and over.
$\frac{1}{8}$ to $\frac{5}{32}$	5.10 to 6.37	10	15	20	..	..	..	..
$\frac{5}{32}$ " $\frac{3}{16}$	6.37 " 7.65	8.5	12.5	17	..	..	..	..
$\frac{3}{16}$ " $\frac{1}{4}$	7.65 "10.20	7	10	15	..	..	..	..
$\frac{1}{4}$	10.20	..	..	..	10	14	18	..
$\frac{5}{16}$	12.75	..	..	..	8	12	16	..
$\frac{3}{8}$	15.30	..	..	..	7	10	13	17
$\frac{7}{16}$	17.85	..	..	..	6	8	10	13
$\frac{1}{2}$	20.40	..	..	..	5	7	9	12
$\frac{9}{16}$	22.95	..	..	..	4.5	6.5	8.5	11
$\frac{5}{8}$	25.50	..	..	..	4	6	8	10
Over $\frac{5}{8}$	..	..	..	..	3.5	5	6.5	9

V. FINISH.

Finish.

14. The finished material shall be free from injurious seams, slivers, flaws, and other defects, and shall have a workmanlike finish.

VI. MARKING.

Marking.

15. The melt number shall be stamped on all finished material and on each test specimen. Rivet and lattice steel and other small pieces may be shipped in securely fastened bundles, with the melt number stamped on an attached metal tag.

VII. INSPECTION.

Inspection.

16. The inspector representing the purchaser shall have free entry, at all times while work on the contract of the purchaser is being performed, to all parts of the manufacturer's works which concern the manufacture of the material ordered. The manufacturer shall afford the inspector, free of cost, all reasonable facilities to satisfy him that the material is being furnished in accordance with these specifications. All tests and inspection shall be made at the place of manufacture prior to shipment, and shall be so conducted as not to interfere unnecessarily with the operation of the works.

AMERICAN SOCIETY FOR TESTING MATERIALS

PHILADELPHIA, PA., U. S. A.

AFFILIATED WITH THE

INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.

STANDARD SPECIFICATIONS FOR STRUCTURAL STEEL FOR SHIPS.

ADOPTED AUGUST 16, 1909.

I. MANUFACTURE.

Process.

1. The steel shall be made by the open-hearth process.

II. CHEMICAL PROPERTIES AND TESTS.

Chemical Composition.

2. The steel shall conform to the following requirements as to chemical composition:

CHEMICAL COMPOSITION.

Elements Considered.	Structural Steel.	Rivet Steel.	Steel Castings.
Phosphorus, max., per cent, { Acid	0.06	0.06	0.08
Phosphorus, max., per cent, { Basic	0.04	0.04	0.05
Sulphur, max., per cent	....	0.05	....

Ladle Analyses.

3. To determine whether the material conforms to the requirements specified in Section 2, an analysis shall be made by the manufacturer from a test ingot taken during the pouring of each melt. A copy of this analysis shall be given to the purchaser or his representative.

4. A check analysis may be made by the purchaser from finished material representing each melt, in which case an excess of 25 per cent above the requirements specified in Section 2 shall be allowed. **Check Analyses.**

III. PHYSICAL PROPERTIES AND TESTS.

5. (*a*) The steel shall conform to the following requirements as to tensile properties: **Tension Tests.**

TENSILE PROPERTIES.

Properties Considered.	Structural Steel.	Rivet Steel.	Steel Castings.
Tensile strength, lb. per sq. in.	55 000 – 65 000	48 000 – 58 000	60 000 min.
Yield point, min., lb. per sq. in.	0.5 tens. str.	0.5 tens. str.	0.5 tens. str.
Elongation in 8 in., min., per cent[1]	$\frac{1\,500\,000}{\text{Tens. str.}}$	$\frac{1\,500\,000}{\text{Tens. str.}}$	.....
Elongation in 2 in., min., per cent[1]	.....	.....	18

[1] See Section 6.

(*b*) The yield point shall be determined by the drop of the beam of the testing machine.

6. (*a*) For material over $\frac{3}{4}$ in. in thickness, a deduction of 1 from the percentage of elongation specified in Section 5 shall be made for each increase of $\frac{1}{8}$ in. in thickness above $\frac{3}{4}$ in. **Modifications in Elongation.**

(*b*) For material under $\frac{5}{16}$ in. in thickness, a deduction of 2.5 from the percentage of elongation specified in Section 5 shall be made for each decrease of $\frac{1}{16}$ in. in thickness below $\frac{5}{16}$ in.

7. All broken tension test specimens of structural and rivet steel shall show a silky fracture; and of steel castings, a silky or fine granular fracture. **Character of Fracture.**

8. (*a*) The test specimen for structural steel shall bend cold through 180 deg. without fracture on the outside of the bent portion, as follows: For material under $\frac{3}{4}$ in. in thickness, flat on itself; for material $\frac{3}{4}$ to $1\frac{1}{4}$ in. in thickness, around a pin the diameter of which is equal to $1\frac{1}{2}$ times the thickness of the specimen; and for material over $1\frac{1}{4}$ in. in thickness, around a pin the diameter of which is equal to twice the thickness of the specimen. **Bend Tests.**

(*b*) A rivet rod shall bend cold through 180 deg. flat on itself without fracture on the outside of the bent portion.

(*c*) The test specimen for steel castings shall bend cold through 90 deg. around a pin the diameter of which is equal to 3 times the thickness of the specimen, without fracture on the outside of the bent portion.

(*d*) Bend tests may be made by pressure or by blows.

Tests of Angles. 9. Angles $\frac{3}{4}$ in. or under in thickness shall open flat, and angles $\frac{1}{2}$ in. or under in thickness shall bend shut, cold, under the blows of a hammer without fracture. This test shall be made only when required by the inspector.

Test Specimens. 10. (*a*) Tension and bend test specimens for structural steel shall be taken from the finished product, and shall be of the full thickness of material as rolled.

Tension test specimens may be of the form and dimensions shown in Fig. 1; or with both edges parallel; or they may be

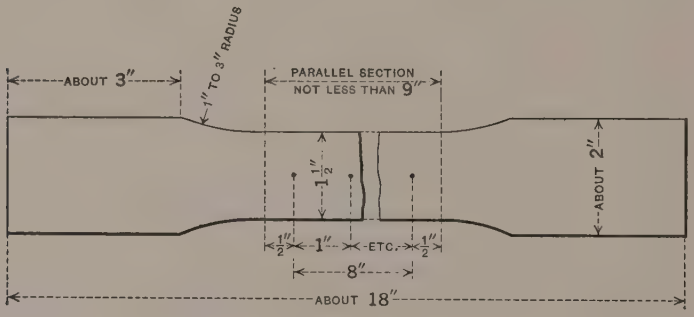

FIG. 1.

turned to a diameter of $\frac{3}{4}$ in. for a length of at least 9 in., with enlarged ends.

The sheared edges of bend test specimens shall be milled or planed.

(*b*) Rivet rods and small rolled bars shall be tested as rolled.

(*c*) Tension and bend test specimens for steel castings shall be taken cold from test bars attached to the castings, or from the sink-heads if they are of sufficient size. All test bars or sink-heads so used shall be annealed with the castings.

Tension test specimens shall be of the form and dimensions shown in Fig. 2.

Bend test specimens shall be 1 by $\frac{1}{2}$ in. in section.

11. (*a*) Material which is to be used without annealing or further treatment shall be tested as rolled. **Annealed Specimens.**

(*b*) Tension test specimens for material which is to be annealed or otherwise treated before use, shall be cut from properly annealed or similarly treated short lengths of the full section of the piece.

12. (*a*) At least one tension and one bend test for structural and rivet steel shall be made from each melt. If material from one melt differs $\frac{3}{8}$ in. or over in thickness, tests shall be made from both the thickest and the thinnest material rolled. **Number of Tests.**

(*b*) The number of tension and bend tests for steel castings will depend on the character and importance of the castings.

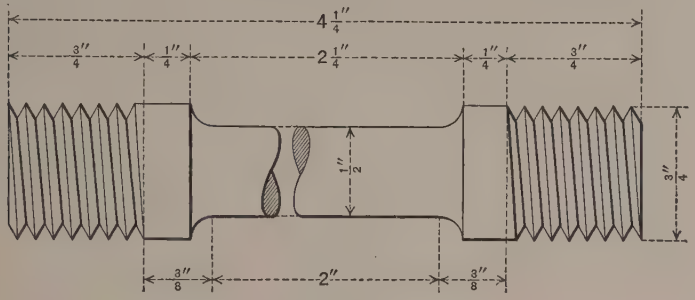

FIG. 2.

(*c*) If any test specimen develops flaws, or if a tension test specimen breaks outside the middle third of the gage length, it may be discarded and another specimen substituted.

13. If the results of the tension tests do not conform to the requirements specified in Section 5, retests may be made. **Retests.**

IV. PERMISSIBLE VARIATIONS IN WEIGHT AND GAGE.

14. The cross-section or weight of each piece of steel shall not vary more than 2.5 per cent from that specified; except in the case of sheared plates, which shall be covered by the following permissible variations to apply to single plates: **Permissible Variations.**

(*a*) *When Ordered to Weight.*—For plates $12\frac{1}{2}$ lb. per sq. ft. or over:

Under 100 in. in width, 2.5 per cent above or below the specified weight;

100 in. in width and over, 5 per cent above or below the specified weight.

For plates under 12½ lb. per sq. ft.:

Under 75 in. in width, 2.5 per cent above or below the specified weight;

75 to 100 in. in width, 5 per cent above or 3 per cent below the specified weight;

100 in. in width and over, 10 per cent above or 3 per cent below the specified weight.

(*b*) *When Ordered to Gage.*—The thickness of each plate shall not vary more than 0.01 in. below that ordered.

An excess over the nominal weight corresponding to the dimensions on the order shall be allowed for each plate, if not more than that shown in the following table, one cubic inch of rolled steel being assumed to weigh 0.2833 lb.:

Thickness Ordered, in.	Nominal Weight, lb. per sq. ft.	Allowable Excess (expressed as percentage of Nominal Weight). For Width of Plate as follows:						
		Under 50 in.	50 in. to 70 in.	70 in. and over	Under 75 in.	75 in. to 100 in.	100 in. to 115 in.	115 in. and over.
1/8 to 5/32	5.10 to 6.37	10	15	20	..	..	..	..
5/32 " 3/16	6.37 " 7.65	8.5	12.5	17	..	..	..	..
3/16 " 1/4	7.65 " 10.20	7	10	15	..	..	..	..
1/4	10.20	..	..	..	10	14	18	..
5/16	12.75	..	..	..	8	12	16	..
3/8	15.30	..	..	..	7	10	13	17
7/16	17.85	..	..	..	6	8	10	13
1/2	20.40	..	..	..	5	7	9	12
9/16	22.95	..	..	..	4.5	6.5	8.5	11
5/8	25.50	..	..	..	4	6	8	10
Over 5/8	..	..	..	..	3.5	5	6.5	9

V. FINISH.

Finish. 15. The finished material shall be free from injurious seams, slivers, flaws, and other defects, and shall have a workmanlike finish.

VI. MARKING.

Marking.

16. The melt number shall be legibly stamped or rolled on all finished material and test specimens, except that small pieces may be shipped in securely fastened bundles, with the melt number legibly stamped on an attached metal tag.

VII. INSPECTION.

Inspection.

17. The inspector representing the purchaser shall have free entry, at all times while work on the contract of the purchaser is being performed, to all parts of the manufacturer's works which concern the manufacture of the material ordered. The manufacturer shall afford the inspector, free of cost, all reasonable facilities to satisfy him that the material is being furnished in accordance with these specifications. All tests and inspection shall be made at the place of manufacture prior to shipment, and shall be so conducted as not to interfere unnecessarily with the operation of the works.

AMERICAN SOCIETY FOR TESTING MATERIALS

PHILADELPHIA, PA., U. S. A.

AFFILIATED WITH THE

INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.

STANDARD SPECIFICATIONS FOR BOILER AND FIREBOX STEEL.

ADOPTED JUNE 1, 1912.

Grades. 1. There shall be two grades of steel for boilers, namely: flange and firebox.

I. MANUFACTURE.

Process. 2. The steel shall be made by the open-hearth process.

II. CHEMICAL PROPERTIES AND TESTS.

Chemical Composition. 3. The steel shall conform to the following requirements as to chemical composition:

	Flange.	Firebox.
Carbon	.....	0.12 – 0.25 per cent
Manganese	0.30 – 0.60	0.30 – 0.50 "
Phosphorus (Acid)	not over 0.05	not over 0.04 "
Phosphorus (Basic)	" " 0.04	" " 0.035 "
Sulphur	" " 0.05	" " 0.04 "
Copper	.....	" " 0.05 "

Ladle Analyses. 4. To determine whether the material conforms to the requirements specified in Section 3, an analysis shall be made by the manufacturer from a test ingot taken during the pouring of each melt. A copy of this analysis shall be given to the purchaser or his representative.

5. A check analysis may be made by the purchaser from a broken tension test specimen representing each plate as rolled, and this analysis shall conform to the requirements specified in Section 3. **Check Analyses.**

III. PHYSICAL PROPERTIES AND TESTS.

6. (*a*) The steel shall conform to the following requirements as to tensile properties: **Tension Tests.**

	Flange.	Firebox.
Tensile strength, lb. per sq. in.....	55 000 – 65 000	52 000 – 62 000
Yield point, min., " "	0.5 tens. str.	0.5 tens. str.
Elongation in 8 in., min., per cent.. (See Section 7)	$\frac{1\,500\,000}{\text{Tens. str.}}$	$\frac{1\,500\,000}{\text{Tens. str.}}$

(*b*) The yield point shall be determined by the drop of the beam of the testing machine.

7. (*a*) For material over $\frac{3}{4}$ in. in thickness, a deduction of 0.5 from the percentage of elongation specified in Section 6 shall be made for each increase of $\frac{1}{8}$ in. in thickness above $\frac{3}{4}$ in. **Modifications in Elongation.**

(*b*) For material $\frac{1}{4}$ in. or under in thickness, the elongation shall be measured on a gage length of 24 times the thickness of the specimen.

8. (*a*) *Cold-bend Tests.*—The test specimen shall bend cold through 180 deg. without fracture on the outside of the bent portion, as follows: For material 1 in. or under in thickness, flat on itself; and for material over 1 in. in thickness, around a pin the diameter of which is equal to the thickness of the specimen. **Bend Tests.**

(*b*) *Quench-bend Tests.*—The test specimen, when heated to a light cherry red as seen in the dark (not less than 1200° F.), and quenched at once in water the temperature of which is between 80° and 90° F., shall bend through 180 deg. without fracture on the outside of the bent portion, as follows: For material 1 in. or under in thickness, flat on itself; and for material over 1 in. in thickness, around a pin the diameter of which is equal to the thickness of the specimen.

(*c*) Bend tests may be made by pressure or by blows.

9. For firebox steel, a sample taken from a broken tension test specimen shall not show any single seam or cavity more than **Homogeneity Tests.**

$\frac{1}{4}$ in. long, in either of the three fractures obtained in the test for homogeneity, which shall be made as follows:

The specimen shall be either nicked with a chisel or grooved on a machine, transversely, about $\frac{1}{16}$ in. deep, in three places about 2 in. apart. The first groove shall be made 2 in. from the square end; each succeeding groove shall be made on the opposite side from the preceding one. The specimen shall then be firmly held in a vise, with the first groove about $\frac{1}{4}$ in. above the jaws, and the projecting end broken off by light blows of a hammer, the bending being away from the groove. The specimen shall be broken at the other two grooves in the same manner. The object of this test is to open and render visible to the eye any seams due to failure to weld up or to interposed foreign matter, or any cavities due to gas bubbles in the ingot. One side of each fracture

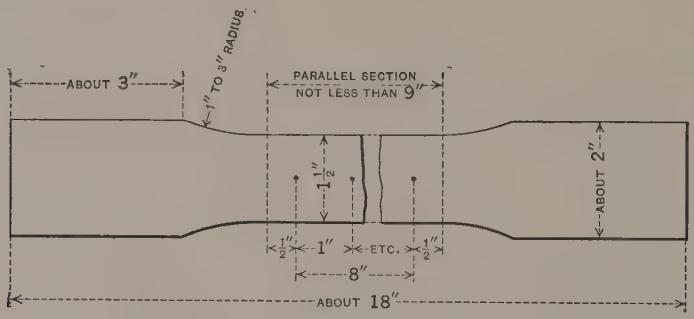

FIG. 1.

shall be examined and the lengths of the seams and cavities determined, a pocket lens being used if necessary.

Test Specimens. 10. (*a*) Tension and bend test specimens shall be taken from the finished product, and shall be of the full thickness of material as rolled.

(*b*) Tension test specimens shall be of the form and dimensions shown in Fig. 1.

The sheared edges of bend test specimens shall be milled or planed.

Number of Tests. 11. (*a*) One tension, one cold-bend, and one quench-bend test shall be made from each plate as rolled.

(*b*) If any test specimen develops flaws, or if a tension test

specimen breaks outside the middle third of the gage length, it may be discarded and another specimen substituted.

IV. PERMISSIBLE VARIATIONS IN WEIGHT AND GAGE.

Permissible Variations.

12. *When Ordered to Gage.*—The thickness of each plate shall not vary more than 0.01 in. below that ordered.

An excess over the nominal weight corresponding to the dimensions on the order shall be allowed for each plate, if not more than that shown in the following table, one cubic inch of rolled steel being assumed to weigh 0.2833 lb.:

Thickness Ordered, in.	Nominal Weight, lb. per sq. ft.	Allowable Excess (expressed as percentage of Nominal Weight). For Width of Plate as follows:						
		Under 50 in.	50 in. to 70 in.	70 in. and over	Under 75 in.	75 in. to 100 in.	100 in. to 115 in.	115 in. and over.
$\frac{1}{8}$ to $\frac{5}{32}$	5.10 to 6.37	10	15	20	..	..	..	..
$\frac{5}{32}$ " $\frac{3}{16}$	6.37 " 7.65	8.5	12.5	17	..	..	..	..
$\frac{3}{16}$ " $\frac{1}{4}$	7.65 " 10.20	7	10	15	..	..	..	..
$\frac{1}{4}$	10.20	..	..	..	10	14	18	..
$\frac{5}{16}$	12.75	..	..	..	8	12	16	..
$\frac{3}{8}$	15.30	..	..	..	7	10	13	17
$\frac{7}{16}$	17.85	..	..	..	6	8	10	13
$\frac{1}{2}$	20.40	..	..	..	5	7	9	12
$\frac{9}{16}$	22.95	..	..	..	4.5	6.5	8.5	11
$\frac{5}{8}$	25.50	..	..	..	4	6	8	10
Over $\frac{5}{8}$	..	..	..	..	3.5	5	6.5	9

V. FINISH.

Finish.

13. The finished material shall be free from injurious seams, slivers, flaws, laminations, and other defects, and shall have a workmanlike finish.

VI. MARKING.

Marking.

14. The name of the manufacturer, melt or slab number, grade, and lowest tensile strength for its grade specified in Section 6, shall be legibly stamped on each plate. The melt or slab number shall be legibly stamped on each test specimen representing that melt or slab.

VII. INSPECTION.

Inspection. 15. The inspector representing the purchaser shall have free entry, at all times while work on the contract of the purchaser is being performed, to all parts of the manufacturer's works which concern the manufacture of the material ordered. The manufacturer shall afford the inspector, free of cost, all reasonable facilities to satisfy him that the material is being furnished in accordance with these specifications. All tests and inspection shall be made at the place of manufacture prior to shipment, and shall be so conducted as not to interfere unnecessarily with the operation of the works.

AMERICAN SOCIETY FOR TESTING MATERIALS

PHILADELPHIA, PA., U. S. A.

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INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.

STANDARD SPECIFICATIONS FOR BOILER RIVET STEEL.

ADOPTED JUNE 1, 1912.

A. Requirements for Rolled Bars.

I. MANUFACTURE.

1. The steel shall be made by the open-hearth process. **Process.**

II. CHEMICAL PROPERTIES AND TESTS.

2. The steel shall conform to the following requirements as to chemical composition: **Chemical Composition.**

Manganese	0.30 – 0.50 per cent
Phosphorus	not over 0.04 "
Sulphur	" " 0.045 "

3. To determine whether the material conforms to the requirements specified in Section 2, an analysis shall be made by the manufacturer from a test ingot taken during the pouring of each melt. A copy of this analysis shall be given to the purchaser or his representative. **Ladle Analyses.**

4. A check analysis may be made by the purchaser from finished material representing each melt, and this analysis shall conform to the requirements specified in Section 2. **Check Analyses.**

III. PHYSICAL PROPERTIES AND TESTS.

Tension Tests.

5. (*a*) The steel shall conform to the following requirements as to tensile properties:

Tensile strength, lb. per sq. in.	45 000 – 55 000
Yield point, min., " "	0.5 tens. str.
Elongation in 8 in., min., per cent.	$\frac{1\,500\,000}{\text{Tens. str.}}$
	(But need not exceed 30 per cent).

(*b*) The yield point shall be determined by the drop of the beam of the testing machine.

Bend Tests.

6. (*a*) *Cold-bend Tests.*—The test specimen shall bend cold through 180 deg. flat on itself without fracture on the outside of the bent portion.

(*b*) *Quench-bend Tests.*—The test specimen, when heated to a light cherry red as seen in the dark (not less than 1200° F.), and quenched at once in water the temperature of which is between 80° and 90° F., shall bend through 180 deg. flat on itself without fracture on the outside of the bent portion.

(*c*) Bend tests may be made by pressure or by blows.

Test Specimens.

7. Tension and bend test specimens shall be taken from the finished bars and shall be of the full-size section of material as rolled.

Number of Tests.

8. Two tension, two cold-bend, and two quench-bend tests shall be made from each melt.

IV. PERMISSIBLE VARIATIONS IN GAGE.

Permissible Variations.

9. The gage of each bar shall not vary more than 0.01 in. from that specified.

V. WORKMANSHIP AND FINISH.

Workmanship.

10. The finished bars shall be circular within 0.01 in.

Finish.

11. The finished bars shall be free from injurious seams, slivers, flaws, and other defects, and shall have a workmanlike finish.

VI. MARKING.

Marking.

12. Rivet steel shall be shipped in securely fastened bundles, with the melt numbers legibly stamped on an attached metal tag.

VII. INSPECTION.

13. The inspector representing the purchaser shall have free entry, at all times while work on the contract of the purchaser is being performed, to all parts of the manufacturer's works which concern the manufacture of the material ordered. The manufacturer shall afford the inspector, free of cost, all reasonable facilities to satisfy him that the material is being furnished in accordance with these specifications. All tests and inspection shall be made at the place of manufacture prior to shipment, and shall be so conducted as not to interfere unnecessarily with the operation of the works. **Inspection.**

B. Requirements for Rivets.

I. PHYSICAL PROPERTIES AND TESTS.

14. The rivets, if tested, shall conform to the requirements as to tensile properties specified in Section 5, except that the elongation shall be measured on a gage length not less than four times the diameter of the rivet. **Tension Tests.**

15. The rivet shank shall bend cold through 180 deg. flat on itself, as shown in Fig. 1, without fracture on the outside of the bent portion. **Bend Tests.**

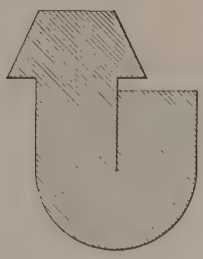

FIG. 1.

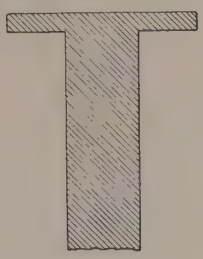

FIG. 2.

16. The rivet heads shall flatten, while hot, to a diameter $2\frac{1}{2}$ times the diameter of the shank, as shown in Fig. 2, without cracking at the edges. **Flattening Tests.**

Number of Tests.

17. (*a*) If the results of the tension tests of the bars from which the rivets are made cannot be furnished, one tension test from each size in each lot of rivets offered for inspection shall be made.

(*b*) Three bend and three flattening tests shall be made from each size in each lot of rivets offered for inspection.

II. WORKMANSHIP AND FINISH.

Workmanship.

18. Rivets shall be true to form, concentric, and shall be made in a workmanlike manner.

Finish.

19. Rivets shall be free from injurious scale, fins, seams, and other defects.

III. REJECTION.

Rejection.

20. Rivets which fail to conform to the requirements specified in Sections 14, 15 and 16 will be rejected, and the manufacturer shall be notified.

AMERICAN SOCIETY FOR TESTING MATERIALS

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INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.

STANDARD SPECIFICATIONS

FOR

STEEL REINFORCING BARS.

ADOPTED JUNE 1, 1912.

Classes.

1. (*a*) There shall be three classes of steel reinforcing bars, namely: plain, deformed, and cold-twisted.

(*b*) Plain and deformed bars are of two grades, namely: structural steel and hard.

Basis of Purchase.

2. (*a*) The hard grade will be used only when specified.

(*b*) If desired, cold-twisted bars may be purchased on the basis of tests of the hot-rolled bars before twisting, in which case such tests shall govern and shall conform to the requirements specified for plain bars of structural steel grade.

I. MANUFACTURE.

Process.

3. (*a*) The steel may be made by the Bessemer or the open-hearth process.

(*b*) Bars shall be rolled from new billets. No re-rolled material will be accepted.

Cold-twisted Bars.

4. Cold-twisted bars shall be twisted cold with one complete twist in a length not over 12 times the thickness of the bar.

II. CHEMICAL PROPERTIES AND TESTS.

Chemical Composition.

5. The steel shall conform to the following requirements as to chemical composition:

Phosphorus	Bessemer,	not over 0.10 per cent
	Open-hearth	" " 0.05 "

Ladle Analyses.

6. To determine whether the material conforms to the requirements specified in Section 5, an analysis shall be made by the manufacturer from a test ingot taken during the pouring of each melt. A copy of this analysis shall be given to the purchaser or his representative.

Check Analyses.

7. A check analysis may be made by the purchaser from finished material representing each melt of open-hearth steel, and from each melt, or lot of ten tons, of Bessemer steel, in which case an excess of 25 per cent above the requirements specified in Section 5 shall be allowed.

III. PHYSICAL PROPERTIES AND TESTS.

Tension Tests.

8. (*a*) The steel shall conform to the following requirements as to tensile properties:

TENSILE PROPERTIES.

Properties Considered.	Plain Bars.		Deformed Bars.		Cold-twisted Bars.
	Structural Steel Grade.	Hard Grade.	Structural Steel Grade.	Hard Grade.	
Tensile strength, lb. per sq. in.	55 000–70 000	80 000 min.	55 000–70 000	80 000 min.	Recorded only.
Yield point, min., lb. per sq. in.	33 000	50 000	33 000	50 000	55 000
Elongation in 8 in., min., per cent.	$\frac{1\,400\,000}{\text{Tens. str.}}$ [1]	$\frac{1\,200\,000}{\text{Tens. str.}}$ [1]	$\frac{1\,250\,000}{\text{Tens. str.}}$ [1]	$\frac{1\,000\,000}{\text{Tens. str.}}$ [1]	5

[1] See Section 9.

(*b*) The yield point shall be determined by the drop of the beam of the testing machine.

Modifications in Elongation.

9. (*a*) For plain and deformed bars over $\frac{3}{4}$ in. in thickness or diameter, a deduction of 1 from the percentage of elongation specified in Section 8 shall be made for each increase of $\frac{1}{8}$ in. in thickness or diameter above $\frac{3}{4}$ in.

(*b*) For plain and deformed bars under $\frac{7}{16}$ in. in thickness or diameter, a deduction of 1 from the percentage of elongation specified in Section 8 shall be made for each decrease of $\frac{1}{16}$ in. in thickness or diameter below $\frac{7}{16}$ in.

10. (*a*) The test specimen shall bend cold around a pin without fracture on the outside of the bent portion, as follows: **Bend Tests.**

BEND TEST REQUIREMENTS.

Thickness or Diameter of Bar.	Plain Bars.		Deformed Bars.		Cold-twisted Bars.
	Structural Steel Grade.	Hard Grade.	Structural Steel Grade.	Hard Grade.	
Under $\frac{3}{4}$ in.	180 deg. d = t	180 deg. d = 3t	180 deg. d = t	180 deg. d = 4t	180 deg. d = 2t
$\frac{3}{4}$ in. or over	180 deg. d = t	90 deg. d = 3t	90 deg. d = 2t	90 deg. d = 4t	180 deg. d = 3t

EXPLANATORY NOTE: d = the diameter of pin about which the specimen is bent; t = the thickness or diameter of the specimen.

(*b*) Bend tests may be made by pressure or by blows.

11. (*a*) Tension and bend test specimens for plain and deformed bars shall be taken from the finished bars, and shall be of the full thickness or diameter of material as rolled; except that the specimens for deformed bars may be planed or turned for a length of at least 9 in., if deemed necessary by the manufacturer to obtain uniform cross-section. **Test Specimens.**

(*b*) Tension and bend test specimens for cold-twisted bars shall be taken from the finished bars, without further treatment; except as provided for in Section 2 (*b*).

12. (*a*) At least one tension and one bend test shall be made from each melt of open-hearth steel, and from each melt, or lot of ten tons, of Bessemer steel. If material from one melt differs $\frac{3}{8}$ in. or more in thickness or diameter, tests shall be made from both the thickest and the thinnest material rolled. **Number of Tests.**

(*b*) If any test specimen develops flaws, or if a tension test specimen breaks outside the middle third of the gage length, it may be discarded and another specimen substituted.

13. If the results of the tension tests do not conform to the requirements specified in Section 8, a retest may be made. **Retests.**

IV. PERMISSIBLE VARIATIONS IN WEIGHT.

14. The weight of any lot of bars shall not vary more than 5 per cent from the theoretical weight of that lot. **Permissible Variations.**

V. FINISH.

Finish. 15. The finished bars shall be free from injurious seams, slivers, flaws, and other defects, and shall have a workmanlike finish.

VI. INSPECTION.

Inspection. 16. The inspector representing the purchaser shall have free entry, at all times while work on the contract of the purchaser is being performed, to all parts of the manufacturer's works which concern the manufacture of the material ordered. The manufacturer shall afford the inspector, free of cost, all reasonable facilities to satisfy him that the material is being furnished in accordance with these specifications.

AMERICAN SOCIETY FOR TESTING MATERIALS

PHILADELPHIA, PA., U. S. A.

AFFILIATED WITH THE

INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.

STANDARD SPECIFICATIONS FOR STEEL AXLES.

ADOPTED SEPTEMBER 1, 1905.

Classes.

1. These specifications cover three classes of axles, namely: car and tender-truck axles; carbon-steel driving and engine-truck axles; and nickel-steel driving and engine-truck axles.

Basis of Purchase.

2. (*a*) Car and tender-truck axles shall not be subject to tensile requirements.

(*b*) Driving and engine-truck axles shall not be subject to drop test requirements.

I. MANUFACTURE.

Process.

3. The steel shall be made by the open-hearth process.

II. CHEMICAL PROPERTIES AND TESTS.

Chemical Composition.

4. The steel shall conform to the following requirements as to chemical composition:

CHEMICAL COMPOSITION.

Elements Considered.	Car and Tender-truck Axles.	Driving and Engine-truck Axles.	
		Carbon Steel.	Nickel Steel.
Manganese, max., per cent.....	....	0.60	....
Phosphorus, max., per cent.....	0.06	0.06	0.04
Sulphur, max., per cent.....	0.06	0.06	0.04
Nickel, per cent.....	....	....	3.0 – 4.0

Chemical Analyses.

5. To determine whether the material conforms to the requirements specified in Section 3, an analysis shall be made by the manufacturer. Drillings for analysis may be taken, at the option of the purchaser, from a test ingot taken during the pouring of each melt; or from the axle, parallel to the axis, at any point one-half the distance from the center to the surface, for car and tender-truck axles; or turnings may be taken from a tension test specimen for driving and engine-truck axles.

III. PHYSICAL PROPERTIES AND TESTS.

Tension Tests.

6. (*a*) The steel for driving and engine-truck axles shall conform to the following minimum requirements as to tensile properties:

	Carbon Steel.	Nickel Steel.
Tensile strength, lb. per sq. in.....	80 000	80 000
Yield point, " "	40 000	50 000
Elongation in 2 in., per cent.....	20	25
Reduction of area, "	25	45

(*b*) The yield point shall be determined by the drop of the beam of the testing machine.

Drop Tests.

7. (*a*) The car and tender-truck axles shall conform to the following drop test requirements:

The test axle shall be so placed on supports that the tup will strike it midway between the ends. It shall be turned over after the first and third blows, and, when required, after the fifth blow. When tested in accordance with the following conditions, the axle shall stand the specified number of blows without fracture and the deflection after the first blow shall not exceed that specified:

Diameter of Axle at Center, in.	Distance between Supports, ft.	Weight of Tup, lb.	Height of Drop, ft.	Number of Blows.	Max. Deflection after First Blow, in.
$4\frac{1}{4}$	3	1640	24	5	$8\frac{1}{4}$
$4\frac{3}{8}$	3	1640	26	5	$8\frac{1}{4}$
$4\frac{7}{16}$	3	1640	$28\frac{1}{2}$	5	$8\frac{1}{4}$
$4\frac{5}{8}$	3	1640	31	5	8
$4\frac{3}{4}$	3	1640	34	5	8
$5\frac{3}{8}$	3	1640	43	5	7
$5\frac{7}{8}$	3	1640	43	7	$5\frac{1}{2}$

(*b*) The deflection is the difference between the distance from a straight edge to the middle point of the axle, measured before the first blow, and the distance measured in the same manner after the blow. The straight edge shall rest only on the collars or the ends of the axle.

(*c*) The atmospheric temperature at the time of testing shall be recorded in the test report.

Drop Test Machine.

8. The anvil of the drop-test machine shall be supported on 12 springs, shall be free to move in a vertical direction, and shall weigh 17,500 lb. The radii of the striking face of the tup and of the supports shall be 5 in.

Test Specimens.

9. (*a*) Tension test specimens shall be taken from the axle. The axis of the specimen shall be located at any point one-half the distance from the center to the surface, and shall be

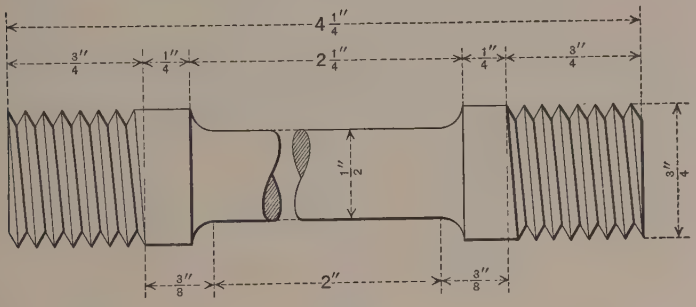

FIG. 1.

parallel to the axis of the axle. Specimens shall be of the form and dimensions shown in Fig. 1.

Number of Tests.

10. (*a*) One tension test for driving and engine-truck axles shall be made from each melt.

(*b*) One drop test for car and tender-truck axles shall be made from each melt.

IV. WORKMANSHIP AND FINISH.

Workmanship.

11. The axles shall conform in sizes, shapes, and limiting weights to the requirements given on the order of the purchaser or the drawing sent with it. In centering, 60-deg. centers with clearance drilled at point shall be used.

Finish. 12. The finished axles shall be free from injurious seams, slivers, flaws and other defects, and shall have a workmanlike finish.

V. MARKING.

Marking. 13. The name or brand of the manufacturer and the melt number shall be legibly stamped on each axle at a place indicated by the purchaser.

VI. INSPECTION.

Inspection. 14. The inspector representing the purchaser shall have free entry, at all times while work on the contract of the purchaser is being performed, to all parts of the manufacturer's works which concern the manufacture of the material ordered. The manufacturer shall afford the inspector, free of cost, all reasonable facilities to satisfy him that the axles are being furnished in accordance with these specifications. All tests and inspection shall be made at the place of manufacture prior to shipment, and shall be so conducted as not to interfere unnecessarily with the operation of the works.

AMERICAN SOCIETY FOR TESTING MATERIALS

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STANDARD SPECIFICATIONS

FOR

HEAT-TREATED CARBON-STEEL AXLES, SHAFTS, AND SIMILAR OBJECTS.

ADOPTED JUNE 1, 1912.

I. MANUFACTURE.

Process. 1. The steel may be made by the open-hearth or by any other approved process.

Discard. 2. A sufficient discard shall be made from the top of each ingot to insure freedom from injurious piping and undue segregation.

Heat Treatment. 3. The axles, shafts, or similar objects shall be allowed to become cold after forging; shall be reheated to the proper temperature to refine the grain (a group thus reheated being known as a "quenching charge"), and quenched in some medium; and then reheated to the proper temperature for annealing.

Prolongation for Tests. 4. For test purposes, a full-size prolongation shall be left on each axle, shaft, or similar object.

Warping. 5. Before offering the parts for test, warped axles, shafts, or similar objects shall be straightened hot, that is, at a temperature above 900° F.

II. CHEMICAL PROPERTIES AND TESTS.

Chemical Composition.

6. The steel shall conform to the following requirements as to chemical composition:

Carbon	not over 0.60 per cent
Manganese	0.40 – 0.80 "
Phosphorus	not over 0.05 "
Sulphur	" " 0.05 "

Chemical Analyses.

7. An analysis shall be made from one axle, shaft, or similar object representing each melt, and this analysis shall conform to the requirements specified in Section 6. Drillings for analysis shall be taken from the crop end, parallel to the axis, at any point one-half the distance from the center to the surface.

In addition to the complete analysis, a phosphorus determination may be made by the purchaser from each broken tension test specimen, and this determination shall conform to the requirement for phosphorus specified in Section 6.

III. PHYSICAL PROPERTIES AND TESTS.

Tension Tests.

8. (*a*) The steel shall conform to the following minimum requirements as to tensile properties:

Tensile strength, lb. per sq. in	85 000
Elastic limit, " "	50 000
Elongation in 2 in., per cent	22
Reduction of area, "	45

(*b*) The elastic limit shall be determined by means of an extensometer. For loads above 8,000 lb. (40,000 lb. per sq. in.), each increment of load shall not be more than 200 lb. (1000 lb. per sq. in.).

Bend Tests.

9. (*a*) The test specimen shall bend cold through 180 deg. around a 1-in. flat mandrel having a rounded edge of $\frac{1}{2}$-in. radius, without fracture on the outside of the bent portion. The form and suggested dimensions of the mandrel are shown in Fig. 1.

(*b*) Bend tests may be made by pressure or by blows.

Test Specimens

10. (*a*) Tension and bend test specimens shall be taken from the crop end of the axle, shaft, or similar object. The axis of the specimen shall be located at any point one-half the dis-

tance from the center to the surface and shall be parallel to the axis of the axle, shaft, or similar object.

(*b*) Tension test specimens shall be of the form and dimensions shown in Fig. 2.

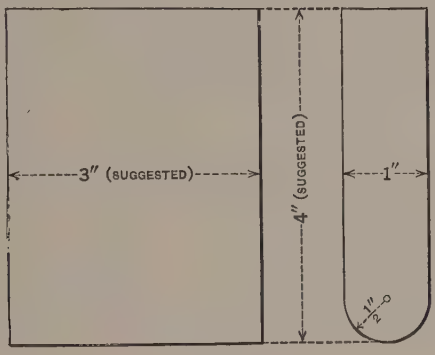

FIG. 1.

Bend test specimens shall be $\frac{1}{2}$ in. square in section, and shall not exceed 6 in. in length.

11. One tension and one bend test shall be made from each annealing charge. If more than one quenching charge is represented in an annealing charge, one tension and one bend **Number of Tests.**

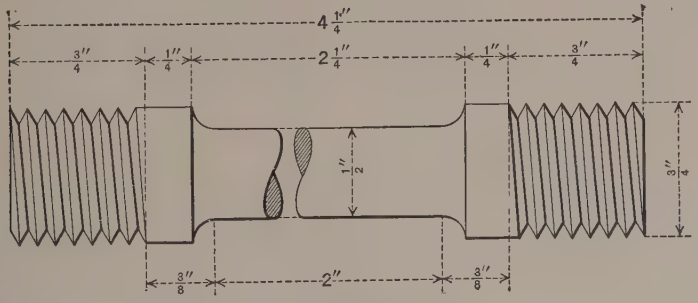

FIG. 2.

test shall be made from each quenching charge. If more than one melt is represented in a quenching charge, one tension and one bend test shall be made from each melt.

12. If the results of the physical tests of any test lot of axles, shafts, or similar objects, do not conform to the requirements **Retests.**

specified in Sections 7 and 8, the manufacturer may re-treat each such test lot. Retests shall then be taken by the purchaser, and these shall govern its acceptance or rejection.

IV. WORKMANSHIP AND FINISH.

Workmanship. 13. The axles, shafts, or similar objects shall conform in sizes and shapes to the requirements given on the order of the purchaser or the drawing sent with it; and unless otherwise specified, shall be rough-turned with an allowance of $\frac{1}{8}$ in. on the surface for finishing, except on the collars of axles or other objects, which shall be left rough-forged. In centering, 60-deg. centers with clearance drilled at point shall be used.

Finish. 14. The finished axles, shafts, or similar objects shall be free from injurious seams, slivers, flaws, and other defects, and shall have a workmanlike finish.

V. MARKING.

Marking. 15. The melt number shall be legibly stamped on the rough axles, shafts, or similar objects. In the case of axles or other objects with collars, the melt number shall be legibly stamped on the rough-forged collar. After rough-turning, the name or brand of the manufacturer, melt number, individual axle or shaft number, and inspector's mark, shall be legibly stamped at a place indicated by the purchaser, except at any point between the rough collars of axles or other objects.

VI. INSPECTION AND REJECTION.

Inspection. 16. (*a*) The inspector representing the purchaser shall have free entry, at all times while work on the contract of the purchaser is being performed, to all parts of the manufacturer's works which concern the manufacture of the material ordered. The manufacturer shall afford the inspector, free of cost, all reasonable facilities to satisfy him that the axles, shafts, or similar objects are being furnished in accordance with these specifications. Tests and inspection at the place of manufacture shall be made prior to shipment.

(*b*) The purchaser may make the tests to govern the acceptance or rejection of material in his own laboratory or elsewhere.

Such tests, however, shall be made at the expense of the purchaser.

(*c*) All tests and inspection shall be so conducted as not to interfere unnecessarily with the operation of the works.

17. (*a*) Axles, shafts, or similar objects which show injurious defects while being finished by the purchaser will be rejected, and the manufacturer shall be notified. **Rejection.**

(*b*) Unless otherwise arranged, any rejection based on tests made in accordance with Section 16 (*b*) shall be reported within five working days from the receipt of samples.

18. Samples tested in accordance with Section 16 (*b*), which represent rejected material, shall be preserved for two weeks from the date of the test report. In case of dissatisfaction with the results of the tests, the manufacturer may make claim for a rehearing within that time. **Rehearing.**

AMERICAN SOCIETY FOR TESTING MATERIALS

PHILADELPHIA, PA., U. S. A.

AFFILIATED WITH THE

INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.

STANDARD SPECIFICATIONS

FOR

FORGED AND ROLLED, FORGED, OR ROLLED SOLID CARBON-STEEL WHEELS FOR ENGINE-TRUCK, TENDER, AND PASSENGER SERVICE.

ADOPTED JUNE 1, 1912.

I. MANUFACTURE.

Process. 1. The steel shall be made by the open-hearth process.

Discard. 2. A sufficient discard shall be made from the top of each ingot from which the blanks are made, to insure freedom from injurious piping and undue segregation.

II. CHEMICAL PROPERTIES AND TESTS.

Chemical Composition. 3. The steel shall conform to the following requirements as to chemical composition:

	Acid.	Basic.
Carbon	0.60 – 0.80	0.65 – 0.85 per cent
Manganese	0.55 – 0.80	0.55 – 0.80 "
Silicon	0.15 – 0.35	0.10 – 0.30 "
Phosphorus	not over 0.05	not over 0.05 "
Sulphur	" " 0.05	" " 0.05 "

4. To determine whether the material conforms to the requirements specified in Section 3, an analysis shall be made from a test ingot taken during the pouring of each melt. A copy of this analysis shall be given to the purchaser or his representative. Ladle Analyses.

5. A check analysis may be made by the purchaser from one wheel representing each melt, and this analysis shall conform to the requirements specified in Section 3. A sample may be taken from any one point in the plate; or two samples may be taken, in which case they shall be on radii at right angles to each other. Samples shall not be taken in such a way as to impair the usefulness of the wheel. Drillings for analysis shall be taken by boring entirely through the sample parallel to the axis of the wheel; they shall be clean and free from scale, oil and other foreign substances. All drillings from any one wheel shall be thoroughly mixed together. Check Analyses.

III. TOLERANCES.

6. Wheels shall be furnished rough-bored and with hubs faced. They may be furnished with contours as rolled without additional machine work, provided they conform to the dimensions specified within the following tolerances: Tolerances.

(*a*) *Height of Flange.*—The height of flange shall not be less, but may be $\frac{1}{8}$ in. more than that specified.

(*b*) *Thickness of Flange.*—The thickness of flange shall not vary more than $\frac{1}{16}$ in. from that specified.

(*c*) *Radius of Throat.*—The radius of throat shall not vary more than $\frac{1}{16}$ in. from that specified.

(*d*) *Thickness of Rim.*—The rim may vary in thickness, but the variation less than that specified shall not exceed $\frac{3}{16}$ in. The thickness of rim shall be measured from a base line drawn from the intersection of the throat r dius and the tread, parallel to the axis of the wheel.

(*e*) *Width of Rim.*—The width of rim shall not vary more than $\frac{1}{8}$ in. from that specified.

(*f*) *Thickness of Plate.*—The plate may vary in thickness, but the variation less than that specified shall not

exceed $\frac{1}{32}$ in. for each $\frac{1}{8}$ in. in the thickness of the plate.

(*g*) *Limit Groove.*—When limit groove is specified, the location of the center of limit-of-wear groove shall not vary more than $\frac{1}{8}$ in. from that specified and its distance from the inner edge of the rim at the thinnest point shall not be less than $\frac{3}{4}$ in.

(*h*) *Diameter of Rough Bore.*—The diameter of rough bore shall not vary more than $\frac{1}{16}$ in. over nor more than $\frac{1}{8}$ in. under that specified. When not specified, the diameter of rough bore shall be $\frac{1}{4}$ in. less than that of the finished bore, subject to the above limitations.

(*i*) *Diameter of Hub.*—The diameter of hub may vary, but the thickness of wall of the finished bored hub shall not be less than $1\frac{1}{8}$ in. at any point for bores 7 in. in diameter or under, nor less than $1\frac{3}{8}$ in., for bores over 7 in. in diameter, unless otherwise specified. The thickness of wall of the hub shall not vary more than $\frac{3}{8}$ in. at any two points on the same wheel.

(*j*) *Length of Hub.*—The length of hub shall not vary more than $\frac{1}{8}$ in. from that specified.

(*k-1*) *Depression of Hub.*—For passenger-truck wheels and wheels of similar design, the depression of hub below the front face of the rim shall not be less, but may be $\frac{1}{8}$ in. more than that specified.

(*k-2*) *Projection of Hub.*—For engine-truck wheels and wheels of similar design, the projection of hub from the back face of the rim shall not be less, but may be $\frac{1}{8}$ in. more than that specified.

(*l*) *Black Spots in Hub.*—Black spots in rough bore within 2 in. of either face of the hub shall not exceed $\frac{1}{16}$ in. in thickness.

(*m*) *Eccentricity of Bore.*—The eccentricity between the tread at its center line and the rough bore shall not exceed $\frac{3}{64}$ in.

(*n*) *Block Marks on Tread.*—Block marks shall not exceed $\frac{1}{64}$ in. in height.

(*o*) *Rotundity.*—The wheels shall be gaged with a ring gage, and the opening between the gage and tread at any point shall not exceed $\frac{1}{32}$ in.

(*p*) *Plane.*—The wheels shall be gaged with a ring gage placed concentric with and perpendicular to the axis of the wheel. All points on the back of the rim equidistant from the center shall be within a variation of $\frac{1}{16}$ in. from the plane of the gage when so placed.

(*q*) *Tape Sizes.*—The wheels shall not vary more than five tapes under nor more than nine tapes over the size specified.

(*r*) *Mating.*—The wheels shall be mated as to tape sizes and shipped in pairs.

Gages and Tape.

7. The gages and tape used shall be based on Master Car Builders' standards.

IV. FINISH.

Finish.

8. (*a*) The wheels shall be free from injurious seams, cracks, laminations, or other defects detrimental to their strength or service.

(*b*) The wheels offered for inspection shall not be painted or covered with any substance that will hide defects, nor rusted to such an extent as to hide defects.

V. MARKING.

Marking.

9. The name or brand of the manufacturer, date, and serial number, shall be legibly stamped on each wheel in such a way that the wheel may be readily identified. The tape size shall be legibly marked on each wheel.

VI. INSPECTION AND REJECTION.

Inspection.

10. (*a*) The inspector representing the purchaser shall have free entry, at all times while work on the contract of the purchaser is being performed, to all parts of the manufacturer's works which concern the manufacture of the material ordered. The manufacturer shall afford the inspector, free of cost, all reasonable facilities to satisfy him that the wheels are being

furnished in accordance with these specifications. Tests and inspection at the place of manufacture shall be made prior to shipment.

(*b*) The purchaser may make the tests to govern the acceptance or rejection of material in his own laboratory or elsewhere. Such tests, however, shall be made at the expense of the purchaser.

(*c*) All tests and inspection shall be so conducted as not to interfere unnecessarily with the operation of the works.

Rejection. 11. Unless otherwise arranged, any rejection based on tests made in accordance with Section 10(*b*) shall be reported within five working days from the receipt of samples.

Rehearing. 12. Samples tested in accordance with Section 10(*b*), which represent rejected material, shall be preserved for two weeks from the date of the test report. In case of dissatisfaction with the results of the tests, the manufacturer may make claim for a rehearing within that time.

AMERICAN SOCIETY FOR TESTING MATERIALS

PHILADELPHIA, PA., U. S. A.

AFFILIATED WITH THE

INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.

STANDARD SPECIFICATIONS

FOR

FORGED AND ROLLED, FORGED, OR ROLLED SOLID CARBON-STEEL WHEELS FOR FREIGHT-CAR SERVICE.

ADOPTED JUNE 1, 1912.

I. MANUFACTURE.

Process. 1. The steel shall be made by the open-hearth process.

Discard. 2. A sufficient discard shall be made from the top of each ingot from which the blanks are made, to insure freedom from injurious piping and undue segregation.

II. CHEMICAL PROPERTIES AND TESTS.

Chemical Composition. 3. The steel shall conform to the following requirements as to chemical composition:

	ACID.	BASIC.
Carbon	0.60 – 0.80	0.65 – 0.85 per cent
Manganese	0.55 – 0.80	0.55 – 0.80 "
Silicon	0.15 – 0.35	0.10 – 0.30 "
Phosphorus	not over 0.05	not over 0.05 "
Sulphur	" " 0.05	" " 0.05 "

Ladle Analyses. 4. To determine whether the material conforms to the requirements specified in Section 3, an analysis shall be made

by the manufacturer from a test ingot taken during the pouring of each melt. A copy of this analysis shall be given to the purchaser or his representative.

Check Analyses.

5. A check analysis may be made by the purchaser from one wheel representing each melt, and this analysis shall conform to the requirements specified in Section 3. A sample may be taken from any one point in the plate; or two samples may be taken, in which case they shall be on radii at right angles to each other. Samples shall not be taken in such a way as to impair the usefulness of the wheel. Drillings for analysis shall be taken by boring entirely through the sample parallel to the axis of the wheel; they shall be clean and free from scale, oil and other foreign substances. All drillings from any one wheel shall be thoroughly mixed together.

III. TOLERANCES.

Tolerances.

6. The wheels may be furnished with contours as rolled, and shall conform to the dimensions specified within the following tolerances:

(*a*) *Height of Flange.*—The height of flange shall not be less, but may be $\frac{1}{8}$ in. more than that specified.

(*b*) *Thickness of Flange.*—The thickness of flange shall not vary more than $\frac{1}{16}$ in. from that specified.

(*c*) *Radius of Throat.*—The radius of throat shall not vary more than $\frac{1}{16}$ in. from that specified.

(*d*) *Thickness of Rim.*—The rim may vary in thickness, but the variation less than that specified shall not exceed $\frac{3}{16}$ in. The thickness of rim shall be measured from a base line drawn from the intersection of the throat radius and the tread, parallel to the axis of the wheel.

(*e*) *Width of Rim.*—The width of rim shall not vary more than $\frac{1}{8}$ in. from that specified.

(*f*) *Thickness of Plate.*—The plate may vary in thickness, but the variation less than that specified shall not exceed $\frac{1}{32}$ in. for each $\frac{1}{8}$ in. in the thickness of the plate.

(*g*) *Limit Groove.*—When limit groove is specified, the location of the center of limit-of-wear groove shall not vary more than $\frac{1}{8}$ in. from that specified and its distance from the inner edge of the rim at the thinnest point shall not be less than $\frac{3}{4}$ in.

(*h*) *Diameter of Rough Bore.*—The diameter of rough bore shall not vary more than $\frac{1}{16}$ in. over nor more than $\frac{1}{8}$ in. under that specified. When not specified, the diameter of rough bore shall be $\frac{1}{4}$ in. less than that of the finished bore, subject to the above limitations.

(*i*) *Diameter of Hub.*—The diameter of hub may vary, but the thickness of wall of the finished bored hub shall not be less than $1\frac{1}{8}$ in. at any point for bores 7 in. in diameter or under, nor less than $1\frac{3}{8}$ in. for bores over 7 in. in diameter, unless otherwise specified. The thickness of wall of the hub shall not vary more than $\frac{1}{2}$ in. at any two points on the same wheel.

(*j*) *Length of Hub.*—The length of hub shall not vary more than $\frac{1}{8}$ in. from that specified.

(*k*) *Depression of Hub.*—The depression of hub below the front face of the rim shall not be less, but may be $\frac{1}{8}$ in. more than that specified.

(*l*) *Black Spots in Hub.*—Black spots in rough bore within 2 in. of either face of the hub shall not exceed $\frac{1}{16}$ in. in depth.

(*m*) *Eccentricity of Bore.*—The eccentricity between the tread at its center line and the rough bore shall not exceed $\frac{3}{64}$ in.

(*n*) *Block Marks on Tread.*—Block marks shall not exceed $\frac{1}{64}$ in. in height.

(*o*) *Rotundity.*—The wheels shall be gaged with a ring gage, and the opening between the gage and tread at any point shall not exceed $\frac{1}{16}$ in.

(*p*) *Plane.*—The wheels shall be gaged with a ring gage placed concentric with and perpendicular to the axis of the wheel. All points on the back of the rim equidistant from the center shall be within a

variation of $\frac{1}{16}$ in. from the plane of the gage when so placed.

(*q*) *Tape Sizes.*—The wheels shall not vary more than five tapes under nor more than nine tapes over the size specified.

(*r*) *Mating.*—The wheels shall be mated as to tape sizes and shipped in pairs.

Gages and Tape. 7. The gages and tape used shall be based on Master Car Builders' standards.

IV. FINISH.

Finish. 8. (*a*) The wheels shall be free from injurious seams, cracks, laminations, and other defects detrimental to their strength or service.

(*b*) The wheels offered for inspection shall not be painted or covered with any substance that will hide defects, nor rusted to such an extent as to hide defects.

V. MARKING.

Marking. 9. The name or brand of the manufacturer, date, and serial number shall be legibly stamped on each wheel in such a way that the wheel may be readily identified. The tape size shall be legibly marked on each wheel.

VI. INSPECTION AND REJECTION.

Inspection. 10. (*a*) The inspector representing the purchaser shall have free entry, at all times while work on the contract of the purchaser is being performed, to all parts of the manufacturer's works which concern the manufacture of the material ordered. The manufacturer shall afford the inspector, free of cost, all reasonable facilities to satisfy him that the wheels are being furnished in accordance with these specifications. Tests and inspection at the place of manufacture shall be made prior to shipment.

(*b*) The purchaser may make the tests to govern the acceptance or rejection of material in his own laboratory or elsewhere. Such tests, however, shall be made at the expense of the purchaser.

(*c*) All tests and inspection shall be so conducted as not to interfere unnecessarily with the operation of the works.

11. Unless otherwise arranged, any rejection based on tests made in accordance with Section 10(*b*) shall be reported within five working days from the receipt of samples. **Rejection.**

12. Samples tested in accordance with Section 10(*b*), which represent rejected material, shall be preserved for two weeks from the date of the test report. In case of dissatisfaction with the results of the tests, the manufacturer may make claim for a rehearing within that time. **Rehearing.**

AMERICAN SOCIETY FOR TESTING MATERIALS

PHILADELPHIA, PA., U. S. A.

AFFILIATED WITH THE

INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.

STANDARD SPECIFICATIONS

FOR

STEEL TIRES.

ADOPTED AUGUST 16, 1909.

Classes.

1. These specifications cover three classes of tires, namely:

Class A, driving tires for passenger engines;

Class B, driving tires for freight engines and tires for engine-truck, tender-truck, trailer and car wheels;

Class C, driving tires for switching engines.

Basis of Purchase.

2. Tires shall be subjected to drop test requirements only when specified in the order.

I. MANUFACTURE.

Process.

3. The steel shall be made by the open-hearth process.

II. CHEMICAL PROPERTIES AND TESTS.

Chemical Composition.

4. The steel shall conform to the following requirements as to chemical composition:

Manganese	not over	0.75	per cent
Silicon	"	"	0.35	"
Phosphorus	"	"	0.05	"
Sulphur	"	"	0.05	"

Chemical Analyses.

5. (*a*) To determine whether the material conforms to the requirements specified in Section 4, an analysis shall be made

by the manufacturer. Drillings for analysis may be taken, at the option of the purchaser, from a test ingot taken during the pouring of each melt; or turnings may be taken from a tension test specimen, or from a tire, when tires are machined by the manufacturer. A copy of this analysis shall be given to the purchaser or his representative, if he so desires.

(*b*) When samples for chemical analysis are taken from the finished material, an excess of 25 per cent above the requirements as to phosphorus and sulphur specified in Section 4 shall be allowed.

III. PHYSICAL PROPERTIES AND TESTS.

Tension Tests.

6. The steel shall conform to the following minimum requirements as to tensile properties:

	CLASS A.	CLASS B.	CLASS C.
Tensile strength, lb. per sq. in....	105 000	115 000	125 000
Elongation in 2 in., per cent.....	12	10	8
Reduction of area, per cent.....	16	14	12

Drop Tests.

7. The test tire shall be placed vertically under the tup in a running position on a solid foundation with an anvil weighing at least ten tons. It shall stand successive blows from a 2240-lb. tup falling from heights of 10, 15, and 20 ft. and upwards, without breaking or cracking, until the following minimum deflection is obtained:

$$D^2 \div (40T^2 + 2D),$$

where D is the internal diameter in inches and T the thickness of the tire at the center of tread in inches.

Tension Test Specimens.

8. (*a*) Tension test specimens shall be taken from test bars from ingots of such size that the test bars shall receive as nearly as practicable the same amount of work as the tire. The specimens shall be of the form and dimensions shown in Fig. 1.

(*b*) If desired by the purchaser, tension test specimens shall also be taken cold from tires which have been subjected to the drop test. The specimen shall be taken from that part of the tire least affected by the drop test. The axis of the specimen shall be at right angles to the radius and parallel to the face of the tire.

Drop Test Specimens.

9. The drop test specimen shall be a test tire from each

melt, selected by the inspector and furnished at the expense of the purchaser provided it conforms to the requirements.

Number of Tests.

10. (*a*) One tension test shall be made from each melt.

(*b*) When drop test requirements are specified in the order, one drop test shall be made from each melt; and one tension test shall also be made from each tire tested, in addition to that specified in Section 10(*a*), if desired by the purchaser.

Retests.

11. If the results of the physical tests of a tire do not conform to the requirements specified, retests on two additional tires from the same melt shall be made at the option of the manufacturer and at his expense; and if each of these conforms to the requirements specified, all the tires in that melt shall be accepted.

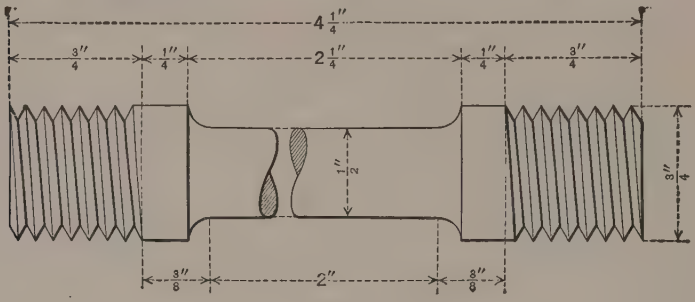

FIG. 1.

IV. TOLERANCES.

Tolerances.

12. When furnished in the rough, the tires shall conform to the dimensions specified within the following tolerances:

(*a*) *Height of Flange.*—The height of flange shall not vary more than $\frac{3}{32}$ in. from that specified.

(*b*) *Thickness of Flange.*—The thickness of flange shall not vary more than $\frac{1}{16}$ in. from that specified.

(*c*) *Radius of Throat.*—The radius of throat shall not vary more than $\frac{1}{8}$ in. over nor more than $\frac{1}{16}$ in. under that specified.

(*d*) *Width of Tire.*—The width of tire shall not vary more than $\frac{1}{8}$ in. over nor more than $\frac{1}{16}$ in. under that specified.

(*e*) *Inside Diameter.*—The inside diameter shall not vary more than $\frac{3}{8}$ in. under the diameter of the finished tire.

(*f*) *Outside Diameter.*—Tires 33 in. or under in inside diameter shall be furnished in sets not varying more than $\frac{1}{16}$ in. in outside diameter and not out of round more than $\frac{1}{16}$ in.; tires over 33 in. in inside diameter shall be furnished in sets not varying more than $\frac{3}{32}$ in. in outside diameter and not out of round more than $\frac{3}{32}$ in.

V. FINISH.

Finish. 13. The tires shall be free from injurious seams, cracks, laminations, or other defects detrimental to their strength or service.

VI. MARKING.

Marking. 14. The name or brand of the manufacturer and the serial number shall be legibly stamped on the tire close to the inside edge, where they will not be cut off at the last turning. Set numbers shall be legibly stenciled on each tire.

VII. INSPECTION AND REJECTION.

Inspection. 15. The inspector representing the purchaser shall have free entry, at all times while work on the contract of the purchaser is being performed, to all parts of the manufacturer's works which concern the manufacture of the material ordered. The manufacturer shall afford the inspector, free of cost, all reasonable facilities to satisfy him that the tires are being furnished in accordance with these specifications. All tests and inspection shall be made at the place of manufacture prior to shipment, and shall be so conducted as not to interfere unnecessarily with the operation of the works.

Rejection. 16. Tires which show injurious defects while being finished by the purchaser will be rejected, and the manufacturer shall replace them at his own expense.

AMERICAN SOCIETY FOR TESTING MATERIALS

PHILADELPHIA, PA., U. S. A.

AFFILIATED WITH THE

INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.

STANDARD SPECIFICATIONS

FOR

STEEL FORGINGS.

ADOPTED SEPTEMBER 1, 1905.

Classes. 1. These specifications cover six classes of forgings, namely: soft or low-carbon steel; carbon steel, unannealed; carbon steel, annealed; carbon steel, oil-tempered; nickel steel, annealed; nickel steel, oil-tempered.

I. MANUFACTURE.

Process. 2. The steel may be made by the Bessemer, open-hearth, or crucible process.

II. CHEMICAL PROPERTIES AND TESTS.

Chemical Composition. 3. The steel shall conform to the following requirements as to chemical composition:

CHEMICAL COMPOSITION.

Elements Considered.	Soft or Low-carbon Steel.	Carbon Steel, Unannealed.	Carbon Steel, Annealed and Oil-tempered.	Nickel Steel, Annealed and Oil-tempered.
Phosphorus, max., per cent.....	0.10	0.06	0.04	0.04
Sulphur, max., per cent.....	0.10	0.06	0.04	0.04
Nickel, per cent.....	....	....	....	3.0 - 4.0

4. To determine whether the material conforms to the requirements specified in Section 3, an analysis shall be made by the manufacturer. Drillings for analysis may be taken, at the option of the purchaser, from a test ingot taken during the pouring of each melt; or from a bend test specimen; or turnings may be taken from a tension test specimen. **Chemical Analyses.**

III. PHYSICAL PROPERTIES AND TESTS.

5. (*a*) The steel shall conform to the following minimum requirements as to tensile properties: **Tension Tests.**

TENSILE REQUIREMENTS.

KIND OF FORGINGS.	Tensile Strength, lb. per sq. in.	Yield Point, lb. per sq. in.	Elastic Limit, lb. per sq. in.	Elongation in 2 in., per cent.	Reduction of Area, per cent.
SOFT OR LOW-CARBON STEEL.					
Solid or hollow, no diameter or thickness of section over 10 in	58 000	29 000	.....	28	35
CARBON STEEL, UNANNEALED.					
Solid or hollow, no diameter or thickness of section over 10 in	75 000	37 500	.....	18	30
CARBON STEEL, ANNEALED.					
Solid or hollow, no diameter or thickness of section over 10 in	80 000	.....	40 000	22	35
Solid, no diameter over 20 in. or thickness of section over 15 in	75 000	.....	37 500	23	35
Solid, diameter over 20 in	70 000	.....	35 000	24	30
CARBON STEEL, OIL-TEMPERED.					
Solid or hollow, no diameter or thickness of section over 3 in	90 000	.....	55 000	20	45
Solid, with rectangular sections not over 6 in. in thickness; or hollow, with walls not over 6 in. in thickness	85 000	.....	50 000	22	45
Solid, with rectangular sections not over 10 in. in thickness; or hollow, with walls not over 10 in. in thickness	80 000	.....	45 000	23	40
NICKEL STEEL, ANNEALED.					
Solid or hollow, no diameter or thickness of section over 10 in	80 000	.....	50 000	25	45
Solid, no diameter over 20 in. or thickness of section over 15 in	80 000	.....	45 000	25	45
Solid, diameter over 20 in	80 000	.....	45 000	24	40
NICKEL STEEL, OIL-TEMPERED.					
Solid or hollow, no diameter or thickness of section over 3 in	95 000	.....	65 000	21	50
Solid, with rectangular sections not over 6 in. in thickness; or hollow, with walls not over 6 in. in thickness	90 000	.....	60 000	22	50
Solid, with rectangular sections not over 10 in. in thickness; or hollow, with walls not over 10 in. in thickness	85 000	.....	55 000	24	45

(*b*) The yield point shall be determined by the drop of the beam of the testing machine.

(*c*) The elastic limit shall be determined by means of an extensometer.

Bend Tests.

6. (*a*) The test specimen shall bend cold through 180 deg., around a pin, without fracture on the outside of the bent portion, as follows:

KIND OF FORGING.	DIAMETER OF PIN, IN.
Soft or low-carbon steel	$\frac{1}{2}$
Carbon steel, unannealed	$1\frac{1}{2}$
Carbon steel, annealed, under 20 in. in diameter	1
Carbon steel, annealed, 20 in. or over in diameter	$1\frac{1}{2}$
Carbon steel, oil-tempered	1
Nickel steel, annealed	$\frac{1}{2}$
Nickel steel, oil-tempered	1

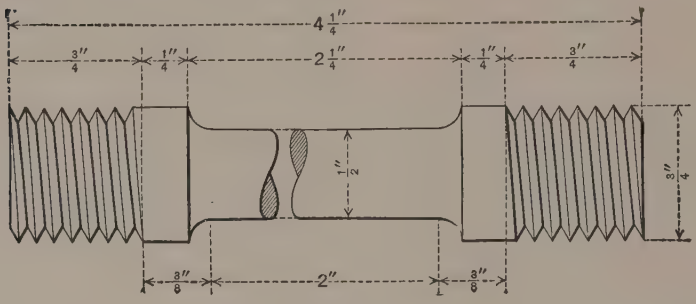

FIG. 1.

(*b*) Bend tests may be made by pressure or by blows.

Test Specimens.

7. (*a*) Tension and bend test specimens shall be taken from the forging or from the full-size prolongation of the same. The axis of the specimen shall be located at any point one-half the distance from the center to the surface and shall be parallel to the axis of the forging in the direction in which the metal is most drawn out or worked. The test specimens for forgings with large ends or collars shall be taken from a prolongation of the same size as the forging back of the large end or collar. The test specimens for hollow forgings, either forged or bored, shall be taken within the finished section prolonged, with the axis of the specimen at any point one-half the distance from the inner to the outer surface of the wall of the forging.

(*b*) Tension test specimens shall be of the form and dimensions shown in Fig. 1.

Bend test specimens shall be 1 by $\frac{1}{2}$ in. in section.

8. The number of tests from a melt or a forging will depend on the character and importance of the forgings. **Number of Tests.**

IV. WORKMANSHIP AND FINISH.

9. The forgings shall conform in sizes and shapes to the requirements given on the order of the purchaser or the drawing sent with it. **Workmanship.**

10. The finished forgings shall be free from injurious seams, slivers, flaws, and other defects, and shall have a workmanlike finish. **Finish.**

V. INSPECTION.

11. The inspector representing the purchaser shall have free entry, at all times while work on the contract of the purchaser is being performed, to all parts of the manufacturer's works which concern the manufacture of the material ordered. The manufacturer shall afford the inspector, free of cost, all reasonable facilities to satisfy him that the material is being furnished in accordance with these specifications. All tests and inspection shall be made at the place of manufacture prior to shipment, and shall be so conducted as not to interfere unnecessarily with the operation of the works. **Inspection.**

AMERICAN SOCIETY FOR TESTING MATERIALS

PHILADELPHIA, PA., U. S. A.

AFFILIATED WITH THE

INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.

STANDARD SPECIFICATIONS

FOR

STEEL CASTINGS.

ADOPTED JUNE 1, 1912.

Classes. 1. These specifications cover two classes of castings, namely:

Class A, ordinary castings for which no physical requirements are specified.

Class B, castings for which physical requirements are specified. These are of three grades: hard, medium, and soft.

Patterns. 2. (*a*) Patterns shall be made so that sufficient finish is allowed to provide for all variations in shrinkage.

(*b*) Patterns shall be painted three colors to represent metal, cores, and finished surfaces. It is recommended that core prints shall be painted black and finished surfaces red.

I. MANUFACTURE.

Process. 3. The steel may be made by the open-hearth, crucible, or by any other approved process.

Heat Treatment. 4. (*a*) Class A castings need not be annealed unless so specified.

(*b*) Class B castings shall be allowed to become cold; shall then be reheated to the proper temperature to refine the grain, and allowed to cool slowly.

II. CHEMICAL PROPERTIES AND TESTS.

Chemical Composition.

5. The steel shall conform to the following requirements as to chemical composition:

	CLASS A.	CLASS B.
Carbon.....	not over 0.30 per cent	....
Phosphorus.....	" " 0.08 "	not over 0.05 per cent
Sulphur.....	....	" " 0.05 "

Ladle Analyses.

6. To determine whether the material conforms to the requirements specified in Section 5, an analysis shall be made by the manufacturer from a test ingot taken during the pouring of each melt. Drillings for analysis shall be taken not less than $\frac{1}{4}$ in. beneath the surface of the test ingot. A copy of this analysis shall be given to the purchaser or his representative.

Check Analyses.

7. A check analysis of Class B castings may be made by the purchaser from a broken tension or bend test specimen, in which case an excess of 20 per cent above the requirements as to phosphorus and sulphur specified in Section 5 shall be allowed. Drillings for analysis shall be taken not less than $\frac{1}{4}$ in. beneath the surface.

III. PHYSICAL PROPERTIES AND TESTS.

Tension Tests.

8. (*a*) The steel for each grade of Class B castings shall conform to the following minimum requirements as to tensile properties:

	HARD.	MEDIUM.	SOFT.
Tensile strength, lb. per sq. in.	80 000	70 000	60 000
Yield point, " "	36 000	31 500	27 000
Elongation in 2 in., per cent.....	15	18	22
Reduction of area, "	20	25	30

(*b*) The yield point shall be determined by the drop of the beam of the testing machine.

Bend Tests.

9. The test specimen for soft castings shall bend cold through 120 deg. and for medium castings through 90 deg., around a 1-in. pin, without fracture on the outside of the bent portion.

Alternative Tests to Destruction.

10. In the case of small or unimportant castings, a test to destruction on three castings from a lot may be substituted for the tension and bend tests. This test shall show the material to be ductile, free from injurious defects, and suitable for the

purpose intended. A lot shall consist of all castings from the same melt, annealed in the same furnace charge.

Test Specimens. 11. (*a*) Test bars shall be attached to Class B castings weighing 500 lb. or over, provided the design of the castings will permit. If the castings weigh less than 500 lb., or are of such a nature that test bars cannot be attached, two test bars shall be cast to represent each melt; or the quality of the castings shall be determined by tests to destruction as specified in Section 10. All test bars shall be annealed with the castings they represent.

The manufacturer and purchaser shall agree whether test bars can be attached to castings, and also on the location of the bars on the castings and the method of casting unattached bars.

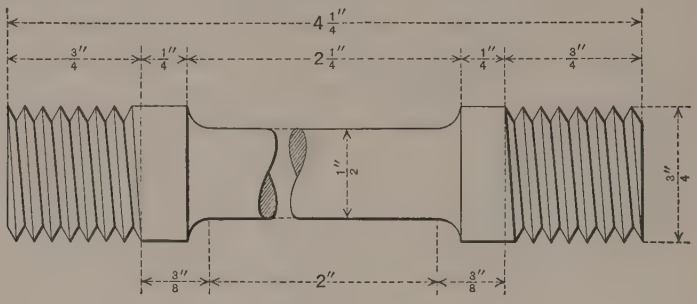

FIG. 1.

(*b*) Tension test specimens shall be of the form and dimensions shown in Fig. 1.

Bend test specimens shall be 1 by $\frac{1}{2}$ in. in section.

Number of Tests. 12. (*a*) One tension and one bend test shall be made from each melt.

(*b*) If any test specimen shows defective machining or develops flaws, or if a tension test specimen breaks outside the gage length, it may be discarded; and the manufacturer and the purchaser or his representative shall agree upon the selection of another specimen in its stead.

IV. WORKMANSHIP AND FINISH.

Workmanship. 13. The castings shall substantially conform to the sizes and shapes of the patterns, and shall be made in a workmanlike manner.

14. (*a*) The castings shall be free from all injurious defects. **Finish.**

(*b*) The castings offered for inspection shall not be painted or covered with any substance that will hide defects, nor rusted to such an extent as to hide defects.

V. INSPECTION AND REJECTION.

15. The inspector representing the purchaser shall have free **Inspection** entry, at all times while work on the contract of the purchaser is being performed, to all parts of the manufacturer's works which concern the manufacture of the material ordered. The manufacturer shall afford the inspector, free of cost, all reasonable facilities to satisfy him that the material is being furnished in accordance with these specifications. All tests and inspection shall be made at the place of manufacture prior to shipment, and shall be so conducted as not to interfere unnecessarily with the operation of the works.

16. Castings which show injurious defects before or after **Rejection.** machining will be rejected, and the manufacturer shall be notified.

AMERICAN SOCIETY FOR TESTING MATERIALS

PHILADELPHIA, PA., U. S. A.

AFFILIATED WITH THE

INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.

STANDARD SPECIFICATIONS FOR AUTOMOBILE CARBON AND ALLOY STEELS.

ADOPTED JUNE 1, 1912.

Basis of Purchase.

1. Automobile steels shall be purchased on the basis of the requirements as to chemical composition specified in Sections 5, 6 and 7. Requirements as to physical properties have been omitted for all steels except castings, because the majority of automobile steels, except castings, are either worked or given special heat treatments by the purchaser. It is recommended that tension and bend tests shall be specified for the material as shipped, whenever it is practicable to do so. When physical requirements are specified, requirements as to carbon shall be omitted.

Steel Castings.

2. (*a*) The term "Steel Castings" shall not include malleable iron castings.

(*b*) The Standard Specifications for Class B Steel Castings, adopted June 1, 1912, by the American Society for Testing Materials, are hereby made a part of these specifications, and shall govern the purchase of automobile steel castings.

I. MANUFACTURE.

Process.

3. The steels may be made by the Bessemer, open-hearth, crucible, electric, or by any other approved process. The entire

process of manufacture and testing shall accord with the best current practice.

4. A sufficient discard shall be made from the top of each ingot to insure freedom from injurious piping and undue segregation. **Discard.**

II. CHEMICAL PROPERTIES AND TESTS.

5. The steels shall conform to the requirements as to chemical composition specified in Tables I to VIII, appended to these specifications, and which are entitled as follows: **Chemical Composition.**

TABLE.	TITLE.
I.....	Automobile Carbon Steels.
II.....	Automobile Nickel Steels.
III.....	Automobile Nickel-Vanadium Steels.
IV.....	Automobile Nickel-Chromium Steels.
V.....	Automobile Nickel-Chromium-Vanadium Steels.
VI.....	Automobile Chromium Steels.
VII.....	Automobile Chromium-Vanadium Steels.
VIII....	Automobile Silico-Manganese Steel and Valve Metals.

6. To determine whether the material conforms to the requirements specified in Tables I to VIII, an analysis shall be made by the manufacturer from a test ingot, or ingots, taken during the pouring of each melt. Drillings for analysis shall be taken not less than $\frac{1}{4}$ in. beneath the surface of the test ingot and in as sound metal as possible. A copy of this analysis shall be given to the purchaser or his representative, if he so desires. **Ladle Analyses.**

7. (*a*) A check analysis may be made by the purchaser, and this analysis shall conform to the requirements specified in Tables I to VIII. **Check Analyses.**

(*b*) Drillings for analysis of bars, billets, or other regular shapes, shall be taken parallel to the axis, at any point one-half the distance from the center to the surface.

(*c*) Drillings for analysis may be taken from a broken tension or a bend test specimen, if physical requirements are specified.

(*d*) Drillings or cuttings for analysis of irregularly shaped pieces for which no physical requirements are specified, shall be taken from both the thickest and the thinnest sections. Surface drillings shall be discarded.

(*e*) Wire, tubing, sheets, and rods less than $1\frac{1}{4}$ in. in thickness, shall be sampled through or across the entire section.

(*f*) In all check analyses, an earnest effort shall be made to determine the composition of the melt or lot, before rejecting material.

(*g*) In case of dispute, the percentage of sulphur shall be determined by the gravimetric (so-called "oxidation" or "aqua regia") method, using all the precautions recognized in the best current practice.

III. PHYSICAL PROPERTIES AND TESTS.

Physical Properties.

8. If physical requirements are specified, the following Sections 9 to 16 shall form a part of the modified specifications.

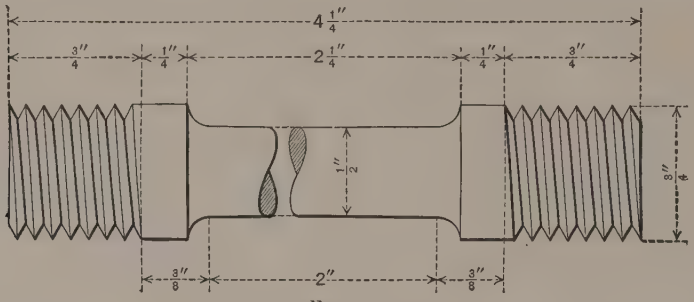

FIG. 1.

Yield Point.

9. The yield point shall be determined by the drop of the beam of the testing machine.

Elastic Limit.

10. The elastic limit shall be determined by means of an extensometer.

Bend Tests.

11. (*a*) The bend test shall be made cold.

(*b*) Bend tests may be made by pressure or by blows.

Tension Test Specimens.

12. (*a*) Tension test specimens for rolled or forged bars, or other regular shapes, shall be taken from the material as rolled or forged. The axis of the specimen shall be located at any point one-half the distance from the center to the surface and shall be parallel to the axis of the shape. The specimens shall be of the form and dimensions shown in Fig. 1.

(*b*) Tension test specimens for irregularly shaped forgings may be taken from the forging or from the full-size prolongation of the same. The specimens shall be of the form and dimensions shown in Fig. 1.

(*c*) Tension test specimens for plates, shapes, etc., shall be taken from the finished product, and shall be of the full thickness of material as rolled. They may be of the form and dimensions shown in Fig. 2; or with both edges parallel; or they may be turned to a diameter of $\frac{3}{4}$ in. for a length of at least 9 in., with enlarged ends.

Bend Test Specimens.

13. Bend test specimens shall be taken from the material as rolled or forged, and shall be $1\frac{1}{2}$ in. wide, if possible. For material $\frac{3}{4}$ in. or under in thickness or diameter, the specimens shall be of the full thickness or diameter of material as rolled or forged; for material over $\frac{3}{4}$ in. in thickness or diameter, the

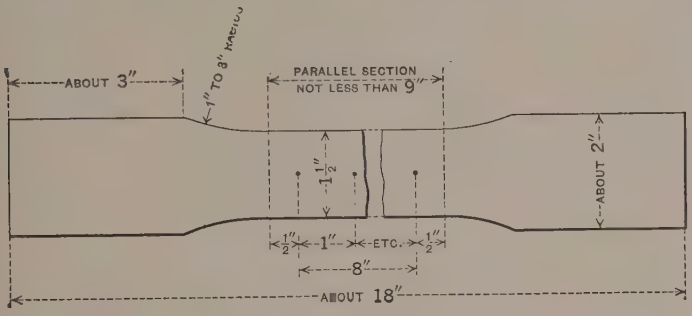

FIG. 2.

specimens may be $\frac{1}{2}$ in. square in section. The sheared edges of specimens shall be milled or planed.

Annealed Specimens.

14. (*a*) Material which is to be used without annealing or further treatment shall be tested as rolled or forged.

(*b*) Tension and bend test specimens for material which is to be annealed or otherwise treated before use, shall be cut from properly annealed or similarly treated short lengths of the full section of the piece.

Number of Tests.

15. (*a*) At least one tension and one bend test shall be made from each melt.

(*b*) If any test specimen shows defective machining or develops flaws, or if a tension test specimen breaks outside the gage length, it may be discarded; and the manufacturer and inspector shall agree upon the selection of another specimen in its stead.

Retests. 16. If the results of the physical tests of any lot of material do not conform to the requirements specified, two retests shall be made and each of these shall conform to the requirements specified.

IV. INSPECTION AND REJECTION.

Inspection. 17. (*a*) The inspector representing the purchaser shall have free entry, at all times while work on the contract of the purchaser is being performed, to all parts of the manufacturer's works which concern the manufacture of the material ordered. The manufacturer shall afford the inspector, free of cost, all reasonable facilities to satisfy him that the material is being furnished in accordance with these specifications. Tests and inspection at the place of manufacture shall be made prior to shipment.

(*b*) The purchaser may make the tests to govern the acceptance or rejection of material in his own laboratory or elsewhere. Such tests, however, shall be made at the expense of the purchaser.

(*c*) All tests and inspection shall be so conducted as not to interfere unnecessarily with the operation of the works.

Rejection. 18. Unless otherwise arranged, any rejection based on tests made in accordance with Section 17(*b*) shall be reported within ten working days from the receipt of samples.

Rehearing. 19. Samples tested in accordance with Section 17(*b*), which represent rejected material, shall be preserved for one month from the date of the test report. In case of dissatisfaction with the results of the tests, the manufacturer may make claim for a rehearing within that time.

APPENDIX.

TABLE I.—AUTOMOBILE CARBON STEELS.

CARBON.		MANGANESE.		PHOS.	SULPH.
Desired.	Permissible Range.	Desired.	Permissible Range.	Not Over	Not Over
0.10	0.05–0.15	0.45	0.30–0.60	0.040	0.045
0.15	0.10–0.20	0.45	0.30–0.60	"	"
0.20	0.15–0.25	0.65	0.50–0.80	"	"
0.25	0.20–0.30	0.55	0.40–0.70	"	"
0.30	0.25–0.35	0.65	0.50–0.80	"	"
0.35	0.30–0.40	0.65	0.50–0.80	"	"
0.40	0.35–0.45	0.65	0.50–0.80	"	"
0.45	0.40–0.50	0.65	0.50–0.80	"	"
0.50	0.45–0.55	0.65	0.50–0.80	"	"
0.60	0.55–0.70	0.65	0.50–0.80	"	"
0.80	0.75–0.90	0.35	0.25–0.50	"	"
0.95	0.90–1.05	0.35	0.25–0.50	"	"
SCREW STOCK.					
0.14	0.08–0.20	0.55	0.30–0.80	0.12	0.06–0.12
STEEL CASTINGS, CLASS B.					
As required for the chemical and physical properties. See Standard Specifications for Steel Castings.					

All values are expressed in per cent.

TABLE II.—AUTOMOBILE NICKEL STEELS.

CARBON.		MANGANESE.		PHOS.	SULPH.	NICKEL.	
Desired.	Permissible Range.	Desired.	Permissible Range.	Not Over	Not Over	Desired.	Permissible Range.
0.15	0.10–0.20	0.65	0.50–0.80	0.040	0.040	3.50	3.25–3.75
0.20	0.15–0.25	"	" "	"	"	"	" "
0.25	0.20–0.30	"	" "	"	"	"	" "
0.30	0.25–0.35	"	" "	"	"	"	" "
0.35	0.30–0.40	"	" "	"	"	"	" "
0.40	0.35–0.45	"	" "	"	"	"	" "
0.45	0.40–0.50	"	" "	"	"	"	" "
0.50	0.45–0 55	"	" "	"	"	"	" "

All values are expressed in per cent.

TABLE III.—AUTOMOBILE NICKEL-VANADIUM STEELS.

CARBON.		MANGANESE.		PHOS.	SULPH.	NICKEL.		VANADIUM.	
Desired.	Permissible Range.	Desired.	Permissible Range.	Not Over	Not Over	Desired.	Permissible Range.	Desired.	Not Under
0.15	0.10–0.20	0.65	0.50–0.80	0.040	0.040	3.50	3.25–3.75	0.18	0.12
0.20	0.15–0.25	"	" "	"	"	"	" "	"	"
0.25	0.20–0.30	"	" "	"	"	"	" "	"	"
0.30	0.25–0.35	"	" "	"	"	"	" "	"	"
0.35	0.30–0.40	"	" "	"	"	"	" "	"	"
0.40	0.35–0.45	"	" "	"	"	"	" "	"	"
0.45	0.40–0.50	"	" "	"	"	"	" "	"	"
0.50	0.45–0.55	"	" "	"	"	"	" "	"	"

All values are expressed in per cent.

TABLE IV.—AUTOMOBILE NICKEL-CHROMIUM STEELS.

WITH LOW NICKEL.

CARBON.		MANGANESE.		PHOS.	SULPH.	NICKEL.		CHROMIUM.	
Desired.	Permissible Range.	Desired.	Permissible Range.	Not Over	Not Over	Desired.	Permissible Range.	Desired.	Permissible Range.
0.15	0.10–0.20	0.65	0.50–0.80	0.040	0.040	1.25	1.00–1.50	0.50	0.30–0.75
0.20	0.15–0.25	"	" "	"	"	"	" "	"	" "
0.25	0.20–0.30	"	" "	"	"	"	" "	"	" "
0.30	0.25–0.35	"	" "	"	"	"	" "	"	" "
0.35	0.30–0.40	"	" "	"	"	"	" "	"	" "
0.40	0.35–0.45	"	" "	"	"	"	" "	"	" "
0.45	0.40–0.50	"	" "	"	"	"	" "	"	" "
0.50	0.45–0.55	"	" "	"	"	"	" "	"	" "

WITH MEDIUM NICKEL.

0.15	0.10–0.20	0.45	0.30–0.60	0.040	0.040	1.75	1.50–2.00	1.00	0.75–1.25
0.20	0.15–0.25	"	" "	"	"	"	" "	"	" "
0.25	0.20–0.30	"	" "	"	"	"	" "	"	" "
0.30	0.25–0.35	"	" "	"	"	"	" "	"	" "
0.35	0.30–0.40	"	" "	"	"	"	" "	"	" "
0.40	0.35–0.45	"	" "	"	"	"	" "	"	" "
0.45	0.40–0.50	"	" "	"	"	"	" "	"	" "
0.50	0.45–0.55	"	" "	"	"	"	" "	"	" "

WITH HIGH NICKEL.

0.15	0.10–0.20	0.45	0.30–0.60	0.040	0.040	3.50	3.25–3.75	1.50	1.25–1.75
0.20	0.15–0.25	"	" "	"	"	"	" "	"	" "
0.25	0.20–0.30	"	" "	"	"	"	" "	"	" "
0.30	0.25–0.35	"	" "	"	"	"	" "	"	" "
0.35	0.30–0.40	"	" "	"	"	"	" "	"	" "
0.40	0.35–0.45	"	" "	"	"	"	" "	"	" "
0.45	0.40–0.50	"	" "	"	"	"	" "	"	" "

All values are expressed in per cent.

TABLE V.—AUTOMOBILE NICKEL-CHROMIUM-VANADIUM STEELS.

WITH LOW NICKEL.

CARBON.		MANGANESE.		PHOS.	SULPH.	NICKEL.		CHROMIUM.		VANADIUM.	
Desired.	Permissible Range.	Desired.	Permissible Range.	Not Over	Not Over	Desired.	Permissible Range.	Desired.	Permissible Range.	Desired.	Not Under
0.15	0.10–0.20	0.65	0.50–0.80	0.040	0.040	1.25	1.00–1.50	0.50	0.30–0.75	0.18	0.12
0.20	0.15–0.25	"	" "	"	"	"	" "	"	" "	"	"
0.25	0.20–0.30	"	" "	"	"	"	" "	"	" "	"	"
0.30	0.25–0.35	"	" "	"	"	"	" "	"	" "	"	"
0.35	0.30–0.40	"	" "	"	"	"	" "	"	" "	"	"
0.40	0.35–0.45	"	" "	"	"	"	" "	"	" "	"	"
0.45	0.40–0.50	"	" "	"	"	"	" "	"	" "	"	"
0.50	0.45–0.55	"	" "	"	"	"	" "	"	" "	"	"

WITH MEDIUM NICKEL.

0.15	0.10–0.20	0.45	0.30–0.60	0.040	0.040	1.75	1.50–2.00	1.00	0.75–1.25	0.18	0.12
0.20	0.15–0.25	"	" "	"	"	"	" "	"	" "	"	"
0.25	0.20–0.30	"	" "	"	"	"	" "	"	" "	"	"
0.30	0.25–0.35	"	" "	"	"	"	" "	"	" "	"	"
0.35	0.30–0.40	"	" "	"	"	"	" "	"	" "	"	"
0.40	0.35–0.45	"	" "	"	"	"	" "	"	" "	"	"
0.45	0.40–0.50	"	" "	"	"	"	" "	"	" "	"	"
0.50	0.45–0.55	"	" "	"	"	"	" "	"	" "	"	"

All values are expressed in per cent.

TABLE VI.—AUTOMOBILE CHROMIUM STEELS.

CARBON.		MANGANESE.		PHOS.	SULPH.	CHROMIUM.	
Desired.	Permissible Range.	Desired.	Permissible Range.	Not Over	Not Over	Desired.	Permissible Range.
0.95	0.90–1.05	0.35	0.20–0.45	0.030	0.030	1.00	0.90–1.10
1.20	1.10–1.30	"	" "	"	"	"	" "
0.95	0.90–1.05	"	" "	"	"	1.20	1.10–1.30
1.20	1.10–1.30	"	" "	"	"	"	" "

All values are expressed in per cent.

TABLE VII.—AUTOMOBILE CHROMIUM-VANADIUM STEELS.

CARBON.		MANGANESE.		PHOS.	SULPH.	CHROMIUM.		VANADIUM.	
Desired.	Permissible Range.	Desired.	Permissible Range.	Not Over	Not Over	Desired.	Permissible Range.	Desired.	Not Under.
0.15	0.10–0.20	0.65	0.50–0.80	0.040	0.040	0.90	0.70–1.10	0.18	0.12
0.20	0.15–0.25	"	" "	"	"	"	" "	"	"
0.25	0.20–0.30	"	" "	"	"	"	" "	"	"
0.30	0.25–0.35	"	" "	"	"	"	" "	"	"
0.35	0.30–0.40	"	" "	"	"	"	" "	"	"
0.40	0.35–0.45	"	" "	"	"	"	" "	"	"
0.45	0.40–0.50	"	" "	"	"	"	" "	"	"
0.50	0.45–0.55	"	" "	"	"	"	" "	"	"
0.95	0.90–1.05	0.35	0.20–0.45	"	"	"	" "	"	"

All values are expressed in per cent.

TABLE VIII.—AUTOMOBILE SILICO-MANGANESE STEEL AND VALVE METALS.

SILICO-MANGANESE STEEL.

CARBON.		MANGANESE.		PHOS.	SULPH.	SILICON.	
Desired.	Permissible Range.	Desired.	Permissible Range.	Not Over	Not Over	Desired.	Permissible Range.
0.50	0.45–0.55	0.65	0.50–0.80	0.040	0.040	1.75	1.50–2.00

VALVE METAL No. 1.

Shall be malleable and contain not less than 96 per cent Nickel.

VALVE METAL No. 2.

						NICKEL.	
.....	Not Over 0.50	.....	Not Over 1.50	0.040	0.040	.....	28.00–35.00

(The remainder shall be iron.)

All values are expressed in per cent.

AMERICAN SOCIETY FOR TESTING MATERIALS

PHILADELPHIA, PA., U. S. A.

AFFILIATED WITH THE

INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.

PRACTICE RECOMMENDED FOR ANNEALING MISCELLANEOUS ROLLED AND FORGED CARBON-STEEL OBJECTS.

ADOPTED AUGUST 21, 1911.

1. *Purpose and General Procedure.*—The usual purpose in annealing miscellaneous forged or rolled carbon-steel objects is to remove existing coarseness of grain. This removal is brought about by heating the object to an annealing temperature, which varies with the carbon content of the metal. But the rate at which the object cools from this annealing temperature influences its properties very profoundly. Hence this rate of cooling should be suited to the duties which the object has to perform in service, and hence to the properties which we seek to give it.

Therefore these specifications first consider the annealing temperature to which the piece must be heated in order to remove existing coarse grain, and then the rate of cooling from that temperature.

Under certain special conditions an annealing is required in order to remove, not coarseness of grain, but the effects of rolling or otherwise working the metal at a temperature so low as to set up serious internal stress. Appropriate treatment for these conditions is given in Section 14.

As these specifications are intended to apply to a great variety of miscellaneous objects, they are purposely made suggestive rather than mandatory in many respects, because no single set of rules can be applied rigorously to such widely varying classes of objects and purposes.

ANNEALING FOR REMOVING EXISTING COARSE GRAIN.

2. *Method of Heating.*—In the case of large objects, the heating of the interior of which lags behind that of the outside, though the early part of the heating may if desired be rapid, the final approach to the annealing temperature aimed at should be slow, so that the interior may be brought fully up to it without carrying the exterior far beyond it, because in general any needlessly high temperature is injurious, and tends to re-coarsen the grain. The temperature should be held long enough at the annealing point to insure that the whole of the interior reaches that point, and that the refining of the grain may become complete. An exposure of one hour should be long enough for pieces twelve inches thick. Thicker pieces need a longer heating.

3. *Control of Temperature. Pyrometers.*—For all important work in careful hands the use of some trustworthy pyrometer is strongly recommended. But most pyrometers should be checked frequently against some standard. For those who are unwilling to take this trouble it is safer to rely on a trained eye than on an unchecked pyrometer. The operator should have clearly before him the fact that no pyrometer indicates the temperature of the interior of the object heated, and that the temperature which most pyrometers indicate is one between the temperature of the outside of the object heated and the temperature of the flame which is supplying the heat. Wherever practicable the part of the pyrometer which is supposed to reach the temperature of the object heated should be in immediate contact with that object, and should be protected from the flame or other source of heat by a suitable insulation, as for instance by covering it with sand. In important cases the gas or other source of heat should be shut off for at least ten minutes before taking the observation.

4. *Control Without the Use of a Pyrometer.*—In working without a pyrometer and relying on the eye, the light surrounding the furnace should be dull, and should be kept as nearly constant as practicable, in order that the eye may not be misled by the changing contrasts between the surrounding light and that of the object heated. In particular, direct sunlight should be excluded, and any arc or other strong lights should be so placed that neither they themselves nor any concentrated part of their light is in the field of the operator's sight when he is estimating by eye the temperature

of the objects to be annealed. Allowance should be made for the brighter surroundings by day than at night, and on sunny than on dark days.

5. *Magnetic Indications.*—The annealing temperature for steels containing between 0.50 and 0.90 per cent. of carbon is that at which the metal suddenly ceases to be magnetic. This fact may sometimes be used for the purpose of fixing or verifying the annealing temperature.

6. *Annealing Temperature.*—In general, the higher the carbon content the lower should be the annealing temperature. Hence different temperatures are given for different ranges of carbon content. Further, in order to bring the interior of large objects up to an effective annealing temperature, their outside may often be raised advantageously somewhat above that temperature. Hence for each range of carbon content a range of temperature is given. The upper limit of this range applied (1) to larger objects, and (2) to the lower part of the range of carbon content given.

The following ranges of temperature should be used for the several ranges of carbon content indicated. They refer to the usual moderate manganese content. For steels with a manganese content greater than 0.75 per cent. slightly lower temperatures suffice.

Range of Carbon Content.	*Range of Annealing Temperature.*
Less than 0.12 per cent.	875 to 925° C. (1607–1697° F.)
0.12 to 0.29 " "	840 " 870 " (1544–1598. ")
0.30 " 0.49 " "	815 " 840 " (1499–1544. ")
0.50 " 1.00 " "	790 " 815 " (1454–1499. ")

7. *Care in Heating.*—Care should be taken that all parts of the object reach the same temperature. To that end it may be necessary to mask from the heat, by means of bricks, the thinner part of objects of varying thickness. When the heating is nearly finished, these bricks may be removed. In particular the flame should never be allowed to touch any part of the object under treatment.

8. *Cooling.*—After the object has been held at the annealing temperature long enough to make its temperature nearly uniform throughout, and to complete the refining of the grain, it should be cooled in a way suited to its carbon content and to giving it the specific properties needed. The general principles are: first,

the higher the carbon the slower should be the cooling; and second, the slower the cooling the softer and more ductile the metal will be, and the lower will be its tensile strength, elastic limit, and yield point. The greatest softness and ductility are obtained at a certain sacrifice of strength and elasticity, and the greatest strength and elasticity at a certain sacrifice of softness and ductility.

For most purposes neither of these extremes is desired, and it is not only sufficient as regards quality but economical to remove the object from the furnace as soon as it has been thoroughly annealed, and to allow it to cool in air, always completely protected not only from rain and snow but from sharp drafts of air. Objects containing more than 0.50 per cent. of carbon should cool more slowly till the color dies out, say at 500° C. (932° F.), as for instance by leaving them in the furnace. They may then be removed and cooled in air. Further, thin objects containing between 0.25 and 0.50 per cent. of carbon should be treated like those of 0.50 per cent. of carbon, unless they can be so massed together that their collective bulk will retard their cooling, so that they will collectively cool even in air with moderate slowness, like single large objects.

SPECIAL ANNEALING METHODS.

9. The foregoing methods are economical because they release the furnaces early for further use. In case special qualities are desired the following methods may be used.

10. *To Give the Greatest Softness and Ductility* of which the metal is capable, even at a certain sacrifice of strength and elastic limit, for instance for ease of machining or to resist a small number of severe distortions, the metal should be cooled slowly, either within the furnace, or in the case of large objects, under a cover of lime, clay, or other slow conductor of heat. The slower the cooling and the lower the temperature to which slow cooling is carried, the softer and weaker will the steel be. But for most cases for which even unusual softness and ductility are required, it suffices to remove the object from the furnace when it has become dead black, and to cool it thenceforth in air.

11. *To Give Great Tensile Strength and High Elastic Limit* even at a certain sacrifice of ductility, the cooling should be more rapid, the rapidity to be governed by the thickness and carbon

content of the object. Thin objects and those with high carbon content cannot stand so rapid a cooling as thick and low-carbon ones, lest their ductility be too far sacrificed. For instance, thick objects with less than 0.50 per cent. of carbon may be cooled completely in air, of course protected from rain or snow. Objects with 0.50 per cent. of carbon or more, and thin objects with from 0.30 to 0.50 per cent. of carbon, may be cooled in air if their cooling is somewhat retarded, as for instance by massing them together, as happens in the case of rails.

12. *To Give an Unusually High Combination of Ductility with Tensile Strength and Elastic Limit. Water or Oil Quenching and Annealing.*—This process needs great care and intelligence, and should in general be used only by those familiar with high-grade steels. After holding at the annealing temperature suited to the particular steel, as indicated in Section 6, the object is quenched in oil, which should be kept in circulation. It may be quenched in water if its carbon content is so low and its shape so simple that it is not in danger of cracking or receiving permanently harmful stress. In any event the danger of such cracking and stress is lessened by removing the object from the oil or water before it has cooled completely, say when its temperature has fallen to 160° C. (320° F.). It should if possible not cool below 100° C. (212° F.) and certainly not below 20° C. (68° F.). The annealing should begin within a very few hours after the quenching and if possible without ever allowing the piece to cool below 100° C. (212° F.) and certainly not below 20° C. (68° F.).

The steel thus hardened should next be annealed by heating to a temperature suited for giving the properties needed. In general the higher this annealing goes, the more ductile will the steel become, and the lower will be its strength and elastic limit.

For very high elastic limit and tensile strength, anneal at 500° to 650° C. (932° to 1202° F.). In this case the ductility will be low. Some steels, such as watch-springs and shafting, are annealed at 350° C. Little commercial annealing is done below 500° C.

For intermediate tensile strength, elastic limit, and ductility, best suited to the majority of cases, anneal at 600° to 650° C. (1112° to 1202° F.).

For the greatest ductility, with good strength and elastic limit, anneal at from 725° to 750° C. (1337° to 1382° F.).

The object should be held at this second annealing temperature long enough not only to allow its interior to reach it, but also to relieve the stress given in the water or oil quenching. For pieces of moderate thickness a four-hour exposure should suffice.

13. *To Give a Moderate Increase of Strength and Elastic Limit above that Given by a Simple Slow Cooling, without the Full Sacrifice of Ductility which a Simple Air Cooling would Cause.*—After holding at the annealing temperature suited to the carbon content, as indicated in Section 6, hasten the cooling till the object is at a dull red, say 650° C. (1202° F.), and henceforth cool slowly. The hastening of the cooling may be brought about in the case of thin objects in relatively shallow furnaces by opening the furnace door till the temperature falls to dull redness; or by running the objects out into the air on a movable car-bottom, and returning them to the furnace when they have cooled to dull redness; or even, in the case of objects with not over 0.30 per cent. carbon and not too thin, by a temporary immersion in oil or even water, followed by a return to the furnace. In cases in which such operations are to be performed frequently, special unfired chambers may be used for the final slow cooling, thus leaving the annealing furnaces proper available for their regular work. The results obtained in this way are not as good as those obtained with the method described in Section 11.

14. *Special Annealing to Remove the Effects of Rolling or Otherwise Working the Object in the Cold or at any Unduly Low Temperature.*—The object should be heated to about 775° C. (1427° F.) and cooled with a slowness which should increase with the thickness, i. e., the least dimension of the piece. In the case of thin plates a mere heating to 725° C. (1337° F.), followed immediately by slow cooling, should suffice. In the case of thick forgings, in which much time may be needed to allow severe stress to relieve itself, the sojourn at 775° C. (1427° F.) may be prolonged for several hours, though always at the cost of superficial decarburizing.

Such annealing for steel containing less than 0.15 per cent. carbon should be at 900° C. (1652° F.). Great brittleness may be caused by annealing very low carbon steel in the neighborhood of 700° C. (1292° F.), after cold working.

AMERICAN SOCIETY FOR TESTING MATERIALS

PHILADELPHIA, PA., U. S. A.

AFFILIATED WITH THE

INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.

STANDARD MAGNETIC TESTS OF IRON AND STEEL.

ADOPTED JUNE 1, 1912.

CORE LOSS.

The power consumption in electrical sheet steel when subjected to an alternating magnetization is known as the core loss. The standard core loss is the total power in watts consumed in each kilogram of material at a temperature of 25° C., when subjected to a harmonically varying induction having a maximum of 10,000 gausses and a frequency of 60 cycles per second, when measured as specified below. It is represented by the symbol $W_{10/60}$.

The ageing coefficient is the percentage change in the standard core loss after continued heating at 100° C. for 600 hours.

The standard core loss shall be measured under the following conditions:

The magnetic circuit consists of 10 kg. (22 lbs.) of the test material, cut with a sharp shear into strips 50 cm. ($19\frac{11}{16}$ ins.) long and 3 cm. ($1\frac{3}{16}$ ins.) wide, half parallel and half at right angles to the direction of rolling, made up into four equal bundles, two containing material parallel and two containing material at right angles to the direction of rolling, and finally built into the four sides of a square with butt joints and opposite sides consisting of material cut in the same manner. No insulation other than the natural scale of the material (except in the case of scale-free material) shall be used between laminations, but the corner joints shall be separated by tough paper 0.01 cm. (0.004 in.) thick.

The magnetizing winding shall consist of four solenoids surrounding the four sides of the magnetic circuit and joined in series. A secondary coil shall be used for energizing the voltmeter and the potential coil of the wattmeter.

These solenoids shall be wound on a form of any non-magnetic non-conducting material of the following dimensions:

Inside cross-section	4 by 4 cm.
Thickness of wall	not over 0.3 cm.
Winding length	42 cm.

The primary winding on each solenoid shall consist of 150 turns of copper wire uniformly wound over the 42-cm. length. The total resistance of the magnetizing winding shall be between 0.3 and 0.5 ohm. The secondary winding of 150 turns of copper wire on each solenoid shall be similarly wound beneath the primary winding. Its resistance shall not exceed 1 ohm.

A voltmeter and the voltage coil of a wattmeter shall be connected in parallel to the terminals of the secondary winding of the apparatus. The current coil of the wattmeter shall be connected in series with the primary winding.

A sine wave electromotive force shall be applied to the primary winding and adjusted until the voltage of the secondary circuit is given by the equation:

$$E = \frac{4 f N n B M}{4 l D 10^8}$$

in which

f = form factor of primary E.M.F.	= 1.11 for sine wave
N = number of secondary turns	= 600
n = number of cycles per second	= 60
B = maximum induction	= 10,000
M = total mass in grams	= 10,000
l = length of strips in centimeters	= 50
D = specific gravity	= 7.5 for high-resistance steel
	= 7.7 for low-resistance steel
E = 106.6 volts for high-resistance steel for sine voltage	
= 103.8 volts for low-resistance steel for sine voltage	

A specific gravity of 7.5 is assumed for all steels having a resistance of over 2 ohms per meter-gram, and 7.7 for all steels having a resistance of less than 2 ohms per meter-gram. These steels are designated as high- and low-resistance steels, respectively.

The wattmeter gives the power consumed in the iron and the secondary circuit. The loss in the secondary circuit is given in terms of the total resistance and voltage. Subtracting this correction term from the total power gives the net power consumed in the steel as hysteresis and eddy current loss. Dividing this value by ten gives the core loss in watts per kilogram.

The Procedure.—1. Cut from the test material a number of strips 3 by 50 cm., half parallel and half at right angles to the direction of rolling.

2. Place on the balance a pile of strips weighing 2.5 kg. Add a second pile of the same kind, bringing the weight up to 5 kg. In each case the weight is taken to the nearest strip. Add in succession two piles of 2.5 kg. each, of the other kind of strips, bringing the weight up to 7.5 kg. and 10 kg. respectively.

3. Secure each bundle by string or tape (not wire) and insert in the apparatus as indicated.

4. Apply the alternating voltage to the primary coil and tap the joints together until the current has a minimum value, as shown by an ammeter in series. Then clamp the corners firmly by some suitable device.

5. Shunt the ammeter and adjust the primary current until the voltmeter indicates the proper value. This adjustment may be made by an auto-transformer, by varying the field of the alternator, or by both, but not by the insertion of resistance or inductance in the primary circuit. Simultaneously the frequency must be adjusted to 60 cycles.

6. Read the wattmeter.

7. Calculations. Subtract from the wattmeter reading the instrument losses, which will be constant for any set of instruments and voltage, and divide by 10. The result is the standard core loss.

NORMAL INDUCTION.

The normal magnetic induction is the induction produced by a magnetizing force in a given piece of magnetic material which has been previously demagnetized and then subjected to many reversals of the given magnetizing force.

Both the induction B and the magnetizing force H shall be expressed in terms of the C. G. S. electromagnetic unit (gauss).

Sheet Metal.—The standard normal induction data for sheet material shall consist of the magnetizing forces corresponding to inductions of 2,000, 4,000, 6,000, 8,000, 10,000, 12,000, 14,000, 16,000, 18,000, 20,000 gausses, or such as may be obtained without exceeding a magnetizing force of 200 gausses.

The following details are to be observed:

The test material shall consist of 5 kg. of the strips cut as indicated for the standard core loss test.

The magnetic circuit shall be a rectangle having the test material for one pair of opposite sides, and the same or different material for the other pair, which may be shorter. The joints at each corner are alternately butt and lap, or may be clamped on the edges.

The magnetomotive force is applied in two sections. The main magnetizing coils shall consist of two equal and uniformly wound solenoids surrounding the test material. The compensating coils shall consist of four short coils, each having the same number of turns wound closely over the ends of the magnetizing coils.

The test coil surrounds the middle portion of each bundle of test material. Four other test coils of half the number of turns are placed over the test material, approximately midway between the yokes and the center. The two center test coils are joined in series and the four end test coils are joined in series. The corresponding ballistic deflections, due to these two test coils, are measures of the magnetic fluxes through the underlying portions of the magnetic circuit. By connecting the two test coils so that the induced electromotive forces oppose each other, and adjusting the current through the compensating magnetizing coils so that there is no resulting ballistic deflection, an approximate uniformity of flux is secured through the greater portion of the test material, and the induction may be measured ballistically in the regular manner. The magnetizing force when the flux is adjusted to uniformity is that calculated from the uniform winding of the main magnetizing solenoids.

The cross-section of the magnetic circuit is determined as in the standard core loss test.

Rods.—The standard test for rods for use in electromagnets shall consist of the magnetizing forces corresponding to inductions

of 2,000, 4,000, 6,000, 8,000, 10,000, 12,000, 14,000, 16,000, 18,000, 20,000 gausses, or such as may be obtained without exceeding a magnetizing force of 200 gausses.

The standard test for rods intended for permanent magnets shall consist in the measurement of the magnetizing force, the residual induction, and the coercive force corresponding to a maximum induction of 14,000 gausses.

Standard tests shall be made by the Burrows compensated double yoke method (described in *Standard Electrical Engineer's Handbook*, and also in *Technical Paper No. 117 of the Bureau of Standards*).

AMERICAN SOCIETY FOR TESTING MATERIALS

PHILADELPHIA, PA., U. S. A.

AFFILIATED WITH THE

INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.

STANDARD SPECIFICATIONS

FOR

ENGINE-BOLT IRON.

ADOPTED JUNE 1, 1912.

I. MANUFACTURE.

Process. 1. The iron shall be made wholly from puddled iron and shall be free from any admixture of iron scrap or steel.

Definition of Terms. 2. *Iron Scrap.*—This term applies only to foreign or bought scrap and does not include local mill products free from foreign or bought scrap.

II. PHYSICAL PROPERTIES AND TESTS.

Tension Tests. 3. (*a*) The iron shall conform to the following requirements as to tensile properties:

Tensile strength, lb. per sq. in. (See Section 4.)	50 000 – 54 000
Yield point, min., lb. per sq. in.	0.6 tens. str.
Elongation in 8 in., min., per cent	25
Reduction of area, " "	40

(*b*) The yield point shall be determined by the drop of the beam of the testing machine. The speed of the cross-head of the machine shall not exceed $1\frac{1}{2}$ in. per minute.

Modifications in Tensile Strength. 4. (*a*) For material over 1.5 and under 5 sq. in. in section, a deduction of 1000 lb. per sq. in. from the tensile strength specified in Section 3 shall be made.

(*b*) For material 5 sq. in. or over in section, a deduction of 2000 lb. per sq. in. from the tensile strength specified in Section 3 shall be made.

Bend Tests. 5. (*a*) *Cold-bend Tests.*—The test specimen shall bend cold through 180 deg. around a pin the diameter of which is equal to the diameter of the specimen, without fracture on the outside of the bent portion.

(*b*) *Hot-bend Tests.*—The test specimen, when heated to a bright cherry red, shall bend through 180 deg. flat on itself without fracture on the outside of the bent portion.

(*c*) *Nick-bend Tests.*—The test specimen, when nicked 25 per cent around with a tool having a 60-deg. cutting edge, to a depth of not less than 8 nor more than 16 per cent of the diameter of the specimen, and broken, shall show a wholly fibrous fracture.

(*d*) Bend tests may be made by pressure or by blows.

Etch Tests.[1] 6. The cross-section of the test specimen shall be ground or polished, and etched for a sufficient period to develop the structure. This test shall show the material to be free from steel.

Test Specimens. 7. (*a*) Tension test specimens shall be of the full section of material as rolled, if possible. Otherwise, the specimens shall be taken from the material as rolled; for bars $2\frac{1}{2}$ in. or less in diameter, the axis of the specimen shall coincide with the axis of the bar; for bars over $2\frac{1}{2}$ in. in diameter, the axis of the specimen shall be located at any point one-half the distance from the center to the surface and shall be parallel to the axis of the bar; and the specimens shall be turned to a diameter of 1 in. for a length of at least 9 in., with enlarged ends.

(*b*) Bend and etch test specimens shall be of the full section of material as rolled; except that for bars over $1\frac{1}{2}$ in. in diameter, the cold-bend test specimen may be machined to not less than 1 sq. in. in section.

Number of Tests. 8. (*a*) Bars of one size shall be sorted into lots of 100 each. Two bars shall be selected at random from each lot or fraction thereof, and tested as specified in Sections 3 and 5; but only one of these bars shall be tested as specified in Section 6.

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[1] A solution of two parts water, one part concentrated hydrochloric acid, and one part concentrated sulphuric acid is recommended for the etch test.

(*b*) If any test specimen from either of the bars originally selected to represent a lot of material, contain surface defects not visible before testing but visible after testing, or if a tension test specimen breaks outside the middle third of the gage length, one retest from a different bar will be allowed.

III. PERMISSIBLE VARIATIONS IN GAGE.

Permissible Variations.

9. The bars shall conform to the standard limit gages adopted by the Master Car Builders' Association in 1883.

IV. FINISH.

Finish.

10. The bars shall be smoothly rolled and free from slivers, depressions, seams, crop ends, and evidences of being burnt.

V. MARKING.

Marking.

11. The bars shall be stamped or marked as designated by the purchaser.

VI. INSPECTION AND REJECTION.

Inspection.

12. (*a*) The inspector representing the purchaser shall have free entry, at all times while work on the contract of the purchaser is being performed, to all parts of the manufacturer's works which concern the manufacture of the material ordered. The manufacturer shall afford the inspector, free of cost, all reasonable facilities to satisfy him that the material is being furnished in accordance with these specifications. Tests and inspection at the place of manufacture shall be made prior to shipment.

(*b*) The purchaser may make the tests to govern the acceptance or rejection of material in his own laboratory or elsewhere. Such tests, however, shall be made at the expense of the purchaser.

Rejection.

13. (*a*) If either of the test bars selected to represent a lot does not conform to the requirements specified in Sections 3, 4, 5, and 6, the lot will be rejected.

(*b*) Bars which develop defects in forging or machining will be rejected, and the manufacturer shall be notified.

AMERICAN SOCIETY FOR TESTING MATERIALS

PHILADELPHIA, PA., U. S. A.

AFFILIATED WITH THE

INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.

STANDARD SPECIFICATIONS

FOR

REFINED WROUGHT-IRON BARS.

ADOPTED JUNE 1, 1912.

I. MANUFACTURE.

Process.

1. Refined wrought-iron bars shall be made wholly from puddled iron, and may consist either of new muck-bar iron or a mixture of muck-bar iron and scrap, but shall be free from any admixture of steel.

II. PHYSICAL PROPERTIES AND TESTS.

Tension Tests.

2. (*a*) The iron shall conform to the following minimum requirements as to tensile properties:

Tensile strength, lb. per sq. in. (See Sections 3 and 4.)	48 000
Yield point, lb. per sq. in.	25 000
Elongation in 8 in., per cent (See Section 5)	22

(*b*) The yield point shall be determined by the drop of the beam of the testing machine. The speed of the cross-head of the machine shall not exceed $1\frac{1}{2}$ in. per minute.

Permissible Variations in Tensile Strength.

3. Twenty per cent of the test specimens representing one size may show tensile strengths 1000 lb. per sq. in. under or 5000 lb. per sq. in. over that specified in Section 2; but no specimen shall show a tensile strength under 45,000 lb. per sq. in.

4. For flat bars which have to be reduced in width, a deduction of 1000 lb. per sq. in. from the tensile strength specified in Sections 2 and 3 shall be made. **Modifications in Tensile Strength**

5. Twenty per cent of the test specimens representing one size may show the following percentages of elongation in 8 in.: **Permissible Variations in Elongation.**

ROUND BARS.

½ in. or over, tested as rolled	20 per cent
Under ½ in., " " "	16 "
Reduced by machining	18 "

FLAT BARS.

⅜ in. or over, tested as rolled	18 per cent
Under ⅜ in., " " "	16 "
Reduced by machining	16 "

6. (*a*) *Cold-bend Tests.*—The test specimen shall bend cold through 180 deg. without fracture on the outside of the bent portion, as follows: For round bars under 2 sq. in. in section, around a pin the diameter of which is equal to the diameter of the specimen; for round bars 2 sq. in. or over in section and for all flat bars, around a pin the diameter of which is equal to twice the diameter or thickness of the specimen. **Bend Tests.**

(*b*) *Hot-bend Tests.*—The test specimen, when heated to a temperature between 1700° and 1800° F., shall bend through 180 deg. without fracture on the outside of the bent portion, as follows: For round bars under 2 sq. in. in section, flat on itself; for round bars 2 sq. in. or over in section and for all flat bars, around a pin the diameter of which is equal to the diameter or thickness of the specimen.

(*c*) *Nick-bend Tests.*—The test specimen, when nicked 25 per cent around for round bars, and along one side for flat bars, with a tool having a 60-deg. cutting edge, to a depth of not less than 8 nor more than 16 per cent of the diameter or thickness of the specimen, and broken, shall not show more than 10 per cent of the fractured surface to be crystalline.

(*d*) Bend tests may be made by pressure or by blows.

7. The cross-section of the test specimen shall be ground **Etch Tests.**[1]

[1] A solution of two parts water, one part concentrated hydrochloric acid, and one part concentrated sulphuric acid is recommended for the etch test.

or polished, and etched for a sufficient period to develop the structure. This test shall show the material to be free from steel.

Test Specimens. 8. (*a*) Tension and bend test specimens shall be of the full section of material as rolled, if possible. Otherwise, the specimens shall be machined from the material as rolled; the axis of the specimen shall be located at any point one-half the distance from the center to the surface of round bars, or from the center to the edge of flat bars, and shall be parallel to the axis of the bar.

(*b*) Etch test specimens shall be of the full section of material as rolled.

Number of Tests. 9. (*a*) All bars of one size shall be piled separately. One bar from each 100 or fraction thereof will be selected at random and tested as specified.

If any test specimen from the bar originally selected to represent a lot of material, contains surface defects not visible before testing but visible after testing, or if a tension test specimen breaks outside the middle third of the gage length, one retest from a different bar will be allowed.

III. PERMISSIBLE VARIATIONS IN GAGE.

Permissible Variations. 10. (*a*) Round bars shall conform to the standard limit gages adopted by the Master Car Builders' Association in 1883.

(*b*) The width or thickness of flat bars shall not vary more than 2 per cent from that specified.

IV. FINISH.

Finish. 11. The bars shall be smoothly rolled and free from slivers, depressions, seams, crop ends, and evidences of being burnt.

V. INSPECTION AND REJECTION.

Inspection. 12. (*a*) The inspector representing the purchaser shall have free entry, at all times while work on the contract of the purchaser is being performed, to all parts of the manufacturer's works which concern the manufacture of the material ordered. The manufacturer shall afford the inspector, free of cost, all reasonable facilities to satisfy him that the material is being furnished in accordance with these specifications. Tests and inspection at the place of manufacture shall be made prior to shipment.

(*b*) The purchaser may make the tests to govern the acceptance or rejection of material in his own laboratory or elsewhere. Such tests, however, shall be made at the expense of the purchaser.

13. All bars of one size will be rejected if the test specimens representing that size do not conform to the requirements specified. **Rejection.**

AMERICAN SOCIETY FOR TESTING MATERIALS

PHILADELPHIA, PA., U. S. A.

AFFILIATED WITH THE

INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.

STANDARD SPECIFICATIONS FOR FOUNDRY PIG IRON.*

ADOPTED AUGUST 16, 1909.

PERCENTAGES AND VARIATIONS.

In order that there may be uniformity in grading, the following percentages and variations shall be used.†

Silicon.		*Sulphur.*	
Per cent.	Code.	Per cent.	Code.
1.00	La	0.04	Sa
1.50	Le	0.05	Se
2.00	Li	0.06	Si
2.50	Lo	0.07	So
3.00	Lu	0.08	Su
3.50	Ly	0.09	Sy
		0.10	Sh
(0.25 allowed either way.)		(Maximum.)	

Total Carbon		*Manganese.*		*Phosphorus.*	
Per cent.	Code.	Per cent.	Code.	Per cent.	Code.
3.00	Ca	0.20	Ma	0.20	Pa
3.20	Ce	0.40	Me	0.40	Pe
3.40	Ci	0.60	Mi	0.60	Pi
3.60	Co	0.80	Mo	0.80	Po
3.80	Cu	1.00	Mu	1.00	Pu
		1.25	My	1.25	Py
		1.50	Mh	1.50	Ph
(Minimum.)		(0.20 allowed either way.)		(0.15 allowed either way.)	

* It is recommended that foundry pig iron be bought by analysis, and that when so bought these Standard Specifications be used.

† These specifications do not advise that all five elements be specified in all contracts for pig iron, but do recommend that when these elements are specified, the given percentages shall be used.

Illustration of the use of above coding: The word Li-se-ca-mo-pi indicates

Sil.	Sul.	Carb.	Mang.	Phos.
2.00	0.05	3.00	0.80	0.60

with variations as allowed.

Percentages of any element specified half way between the above shall be designated by the addition of the letter X to the next lower symbol.

Example.—PeX indicates Phosphorus 0.50, with "allowed" variations (0.15) up and down.

In the case of phosphorus and manganese, the percentages may be used as maximum or minimum figures, but unless so specified they will be considered to include the variations above given.

SAMPLING AND ANALYSIS.

Each car load, or its equivalent, shall be considered as a unit in sampling.

One sample shall be taken to every four tons in the car, and shall be so chosen from different parts of the car as to represent as nearly as possible the average quality of the iron.

Drillings shall be taken so as to fairly represent the composition of the pig as cast.

An equal weight of the drillings from each pig shall be thoroughly mixed to make up the sample for analysis.

In case of dispute, the sampling and analysis shall be made by an independent chemist, mutually agreed upon, if practicable, at the time the contract is made.

It is recommended that the standard methods of the American Foundrymen's Association be used for analysis. Gravimetric methods shall be used for the analysis of sulphur, unless otherwise specified in the contract.

The cost of re-sampling and re-analysis shall be borne by the party in error.

BASE OR QUOTING PRICE.

For market quotations, an iron of 2.00 per cent. in silicon (with variations of 0.25 either way) and 0.05 per cent. in sulphur (maximum) shall be taken as the base.

THE AMERICAN FOUNDRYMEN'S ASSOCIATION SUGGESTS THE FOLLOWING CLAUSES FOR THE PURPOSE OF ADJUSTING DISPUTES BETWEEN BUYER AND SELLER.

Base Table.—The following table may be filled out, and may become a part of the contract. "B", or Base, represents the price agreed upon for a pig iron running 2.00 per cent. in silicon (with allowed variation of 0.25 either way) and under 0.05 per cent. in sulphur; "C" is a constant differential to be determined at the time the contract is made.

This table is for settling any differences which may arise in filling a contract, as explained under penalties and allowances, and may be used to regulate the price of a grade of pig iron which the purchaser desires, and the seller agrees, to substitute for the one originally specified.

Silicon percentages allow 0.25 variation either way. Sulphur percentages are maximum.

Sulphur, per cent.	*Silicon, per cent.*									
	3.25	3.00	2.75	2.50	2.25	2.00	1.75	1.50	1.25	1.00
0.04..	B+6C	B+5C	B+4C	B+3C	B+2C	B+1C	B	B—1C	B—2C	B—3C
0.05..	B+5C	B+4C	B+3C	B+2C	B+1C	B	B—1C	B—2C	B—3C	B—4C
0.06..	B+4C	B+3C	B+2C	B+1C	B	B—1C	B—2C	B—3C	B—4C	B—5C
0.07..	B+3C	B+2C	B+1C	B	B—1C	B—2C	B—3C	B—4C	B—5C	B—6C
0.08..	B+2C	B+1C	B	B—1C	B—2C	B—3C	B—4C	B—5C	B—6C	B—7C
0.09..	B+1C	B	B—1C	B—2C	B—3C	B—4C	B—5C	B—6C	B—7C	B—8C
0.10..	B	B—1C	B—2C	B—3C	B—4C	B—5C	B—6C	B—7C	B—8C	B—9C

Penalties.—In case the iron, when delivered, does not conform to the specifications, the buyer shall have the option of either refusing the iron, or accepting it on the basis shown in the above table, which must be filled out at the time the contract is made.

Allowances.—In case the furnace cannot, for any good reason, deliver the iron as specified at the time delivery is due, the purchaser may at his option accept any other analysis which the furnace can deliver, the price to be determined by the base table above, which must be filled out at the time the contract is made.

AMERICAN SOCIETY FOR TESTING MATERIALS

PHILADELPHIA, PA., U. S. A.

AFFILIATED WITH THE

INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.

STANDARD SPECIFICATIONS FOR CAST-IRON PIPE AND SPECIAL CASTINGS.

ADOPTED NOVEMBER 15, 1904.

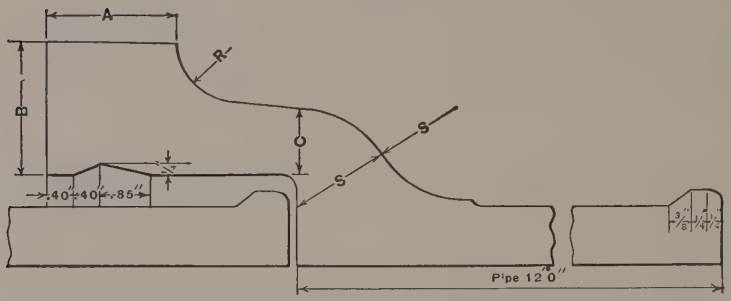
DESCRIPTIONS OF PIPES.

SECTION 1. The pipes shall be made with hub and spigot joints, and shall accurately conform to the dimensions given in Tables I and II. They shall be straight and shall be true circles in section, with their inner and outer surfaces concentric, and shall be of the specified dimensions in outside diameter. They shall be at least 12 feet in length, exclusive of socket. For pipes of each size from 4-inch to 24-inch, inclusive, there shall be two standards of outside diameter, and for pipes from 30-inch to 60-inch, inclusive, there shall be four standards of outside diameter, as shown by Table II.

All pipes having the same outside diameter shall have the same inside diameter at both ends. The inside diameter of the lighter pipes of each standard outside diameter shall be gradually increased for a distance of about 6 inches from each end of the pipe so as to obtain the required standard thickness and weight for each size and class of pipe.

Pipes whose standard thickness and weight are intermediate between the classes in Table II shall be made of the same outside diameter as the next heavier class. Pipes whose standard thickness and weight are less than shown by Table II shall be

TABLE I.—GENERAL DIMENSIONS OF PIPES.



Nominal Diam., ins.	Classes	Actual Outside Diam., ins.	Diam. of Sockets.		Depth of Sockets.		A	B	C
			Pipe, ins.	Special Castings, ins.	Pipe, ins.	Special Castings, ins.			
4	A—B	4.80	5.60	5.70	3.50	4.00	1.5	1.30	0.65
4	C—D	5.00	5.80	5.70	3.50	4.00	1.5	1.30	0.65
6	A—B	6.90	7.70	7.80	3.50	4.00	1.5	1.40	0.70
6	C—D	7.10	7.90	7.80	3.50	4.00	1.5	1.40	0.70
8		9.05	9.85	10.00	4.00	4.00	1.5	1.50	0.75
8	C—D	9.30	10.10	10.00	4.00	4.00	1.5	1.50	0.75
10	A—B	11.10	11.90	12.10	4.00	4.00	1.5	1.50	0.75
10	C—D	11.40	12.20	12.10	4.00	4.00	1.5	1.60	0.80
12	A—B	13.20	14.00	14.20	4.00	4.00	1.5	1.60	0.80
12	C—D	13.50	14.30	14.20	4.00	4.00	1.5	1.70	0.85
14	A—B	15.30	16.10	16.10	4.00	4.00	1.5	1.70	0.85
14	C—D	15.65	16.45	16.45	4.00	4.00	1.5	1.80	0.90
16	A—B	17.40	18.40	18.40	4.00	4.00	1.75	1.80	0.90
16	C—	17.80	18.80	18.80	4.00	4.00	1.75	1.90	1.00
18	A—B	19.50	20.50	20.50	4.00	4.00	1.75	1.90	0.95
18	C—D	19.92	20.92	20.92	4.00	4.00	1.75	2.10	1.05
20	A—B	21.60	22.60	22.60	4.00	4.00	1.75	2.00	1.00
20	C—D	22.06	23.06	23.06	4.00	4.00	1.75	2.30	1.15
24	A—B	25.80	26.80	26.80	4.00	4.00	2.00	2.10	1.05
24	C—D	26.32	27.32	27.32	4.00	4.00	2.00	2.50	1.25
30	A	31.74	32.74	32.74	4.50	4.50	2.00	2.50	1.15
30	B	32.00	33.00	33.00	4.50	4.50	2.00	2.30	1.15
30	C	32.40	33.40	33.40	4.50	4.50	2.00	2.60	1.32
30	D	32.74	33.74	33.74	4.50	4.50	2.00	3.00	1.50
36	A	37.96	38.96	38.96	4.50	4.50	2.00	2.50	1.25
36	B	38.30	39.30	39.30	4.50	4.50	2.00	2.80	1.40
36	C	38.70	39.70	39.70	4.50	4.50	2.00	3.10	1.60
36	D	39.16	40.16	40.16	4.50	4.50	2.00	3.40	1.80
42	A	44.20	45.20	45.20	5.00	5.00	2.00	2.80	1.40
42	B	44.55	45.50	45.50	5.00	5.00	2.00	3.00	1.50
42	C	45.10	46.10	46.10	5.00	5.00	2.00	3.40	1.75
42	D	45.58	46.58	46.58	5.00	5.00	2.00	3.80	1.95
48	A	50.50	51.50	51.50	5.00	5.00	2.00	3.00	1.50

TABLE I.—(CONTINUED.)

Nominal Diam., ins.	Classes.	Actual Outside Diam., ins.	DIAM. OF SOCKETS.		DEPTH OF SOCKETS.		A	B	C
			Pipe, ins.	Special Castings, ins.	Pipe, ins.	Special Castings, ins.			
48	B	50.80	51.80	51.80	5.00	5.00	2.00	3.30	1.65
48	C	51.40	52.40	52.40	5.00	5.00	2.00	3.80	1.95
48	D	51.98	52.98	52.98	5.00	5.00	2.00	4.20	2.20
54	A	56.66	57.66	57.66	5.50	5.50	2.25	3.20	1.60
54	B	57.10	58.10	58.10	5.50	5.50	2.25	3.60	1.80
54	C	57.80	58.80	58.80	5.50	5.50	2.25	4.00	2.15
54	D	58.40	59.40	59.40	5.50	5.50	2.25	4.40	2.45
60	A	62.80	63.80	63.80	5.50	5.50	2.25	3.40	1.70
60	B	63.40	64.40	64.40	5.50	5.50	2.25	3.70	1.90
60	C	64.20	65.20	65.20	5.50	5.50	2.25	4.20	2.25
60	D	64.82	65.82	65.82	5.50	5.50	2.25	4.70	2.60

made of the same outside diameter as the Class A pipes, and pipes whose thickness and weight are more than shown by Table II shall be made of the same outside diameter as the Class D pipes.

For pipes 4-inch to 12-inch, inclusive, one class of special castings shall be furnished, made from Class D pattern. Those having spigot ends shall have outside diameters of spigot ends midway between the two standards of outside diameter as shown by Table II, and shall be tapered back for a distance of 6 inches. For pipes from 14-inch to 24-inch, inclusive, two classes of special castings shall be furnished, Class B special castings with Classes A and B pipes, and Class D special castings with Classes C and D pipes, the former to be stamped "AB" and the latter to be stamped "CD." For pipes 30-inch to 60-inch, inclusive, four classes of special castings shall be furnished, one for each class of pipe, and shall be stamped with the letter of the class to which they belong.

ALLOWABLE VARIATION IN DIAMETER OF PIPES AND SOCKETS.

SECTION 2. Especial care shall be taken to have the sockets of the required size. The sockets and spigots will be tested by circular gauges, and no pipe will be received which is defective in joint room from any cause. The diameters of the sockets and the outside diameters of the bead ends of the pipes shall not vary

TABLE II.—STANDARD THICKNESSES AND WEIGHTS OF CAST-IRON PIPE.

Nominal Inside Diam., ins.	CLASS A. 100 FT. HEAD. 43 LBS. PRESSURE.			CLASS B. 200 FT. HEAD. 86 LBS. PRESSURE.			CLASS C. 300 FT. HEAD. 130 LBS. PRESSURE.			CLASS D. 400 FT. HEAD. 173 LBS. PRESSURE.			Nominal Inside Diam., ins.
	Thickness, ins.	Weight per		Thickness, ins.	Weight per		Thickness, ins.	Weight per		Thickness, ins.	Weight per		
		Foot.	Length.		Foot.	Length.		Foot.	Length.		Foot.	Length.	
4	0.42	20.0	240	0.45	21.7	260	0.48	23.3	280	0.52	25.0	300	4
6	0.44	30.8	370	0.48	33.3	400	0.51	35.8	430	0.55	38.3	460	6
8	0.46	42.9	515	0.51	47.5	570	0.56	52.1	625	0.60	55.8	670	8
10	0.50	57.1	685	0.57	63.8	765	0.62	70.8	850	0.68	76.7	920	10
12	0.54	72.5	870	0.62	82.1	985	0.68	91.7	1,100	0.75	100.0	1,200	12
14	0.57	89.6	1,075	0.66	102.5	1,230	0.74	116.7	1,400	0.82	129.2	1,550	14
16	0.60	108.3	1,300	0.70	125.0	1,500	0.80	143.8	1,725	0.89	158.3	1,900	16
18	0.64	129.2	1,550	0.75	150.0	1,800	0.87	175.0	2,100	0.96	191.7	2,300	18
20	0.67	150.0	1,800	0.80	175.0	2,100	0.92	208.3	2,500	1.03	229.2	2,750	20
24	0.76	204.2	2,450	0.89	233.3	2,800	1.04	279.2	3,350	1.16	306.7	3,680	24
30	0.88	291.7	3,500	1.03	333.3	4,000	1.20	400.0	4,800	1.37	450.0	5,400	30
36	0.99	391.7	4,700	1.15	454.2	5,450	1.36	545.8	6,550	1.58	625.0	7,500	36
42	1.10	512.5	6,150	1.28	591.7	7,100	1.54	716.7	8,600	1.78	825.0	9,900	42
48	1.26	666.7	8,000	1.42	750.0	9,000	1.71	908.3	10,900	1.96	1,050.0	12,600	48
54	1.35	800.0	9,600	1.55	933.3	1,200	1.90	1,141.7	13,700	2.23	1,341.7	16,100	54
60	1.39	916.7	11,000	1.67	1,104.2	13,250	2.00	1,341.7	16,100	2.38	1,583.3	19,000	60

The above weights are for 12 feet laying lengths and standard sockets; proportionate allowance to be made for any variation therefrom.

from the standard dimensions by more than 0.06 inch for pipes 16 inches or less in diameter; 0.08 inch for 18-inch, 20-inch and 24-inch pipes; 0.10 inch for 30-inch, 36-inch and 42-inch pipes; 0.12 inch for 48-inch pipes; and 0.15 inch for 54-inch and 60-inch pipes.

ALLOWABLE VARIATION IN THICKNESS.

SECTION 3. For pipes whose standard thickness is less than 1 inch, the thickness of metal in the body of the pipe shall not be more than 0.08 inch less than the standard thickness; and for pipes whose standard thickness is 1 inch or more, the variation shall not exceed 0.10 inch, except that for spaces not exceeding 8 inches in length in any direction, variations from the standard thickness of 0.02 inch in excess of the allowance above given shall be permitted.

For special castings of standard patterns a variation of 50 per cent. greater than allowed for straight pipe shall be permitted.

DEFECTIVE SPIGOTS MAY BE CUT.

SECTION 4. Defective spigot ends on pipes 12 inches or more in diameter may be cut off in a lathe, and a half-round wrought-iron band shrunk into a groove cut in the end of the pipe. Not more than 12 per cent. of the total number of accepted pipes of each size shall be cut and banded, and no pipe shall be banded which is less than 11 feet in length, exclusive of the socket.

In case the length of a pipe differs from 12 feet, the standard weight of the pipe given in Table II shall be modified in accordance therewith.

SPECIAL CASTINGS.

SECTION 5. All special castings shall be made in accordance with the cuts and the dimensions given in the table forming a part of these specifications.

The diameters of the sockets and the external diameters of the bead ends of the special castings shall not vary from the standard dimensions by more than 0.12 inch for castings 16 inches or less in diameter; 0.15 inch for 18-inch, 20-inch and 24-inch pipes; 0.20 inch for 30-inch, 36-inch and 42-inch pipes; and 0.24 inch for 48-inch, 54-inch and 60-inch pipes. These variations apply only to special castings made from standard patterns.

The flanges on all manhole castings and manhole covers shall be faced true and smooth, and drilled to receive bolts of the sizes given in the tables. The manufacturer shall furnish and deliver all bolts for bolting on the manhole covers, the bolts to be of the sizes shown on plans and made of the best quality of mild steel, with hexagonal heads and nuts and sound, well-fitting threads.

MARKING.

SECTION 6. Every pipe and special casting shall have distinctly cast upon it the initials of the maker's name. When cast especially to order, each pipe and special casting larger than 4-inch may also have cast upon it figures showing the year in which it was cast and a number signifying the order in point of time in which it was cast, the figures denoting the year being above and the number below, thus:

1901	1901	1901
1	2	3

etc., also any initials, not exceeding four, which may be required by the purchaser. The letters and figures shall be cast on the outside and shall be not less than 2 inches in length and $\frac{1}{8}$ inch in relief for pipes 8 inches in diameter and larger. For smaller sizes of pipes the letters may be 1 inch in length. The weight and the class letter shall be conspicuously painted in white on the inside of each pipe and special casting after the coating has become hard.

ALLOWABLE PERCENTAGE OF VARIATION IN WEIGHT.

SECTION 7. No pipe shall be accepted the weight of which shall be less than the standard weight by more than 5 per cent. for pipes 16 inches or less in diameter, and 4 per cent. for pipes more than 16 inches in diameter; and no excess above the standard weight of more than the given percentages for the several sizes shall be paid for. The total weight to be paid for shall not exceed for each size and class of pipe received the sum of the standard weights of the same number of pieces of the given size and class by more than 2 per cent.

No special casting shall be accepted the weight of which shall be less than the standard weight by more than 10 per cent. for pipes 12 inches or less in diameter, and 8 per cent. for larger sizes, except that curves, Y-pieces and breeches pipe may be 12 per cent. below the standard weight, and no excess above the standard weight of more than the above percentages for the several sizes will be paid for. These variations apply only to castings made from the standard patterns.

QUALITY OF IRON.

SECTION 8. All pipes and special castings shall be made of cast iron of good quality, and of such character as shall make the metal of the castings strong, tough and of even grain, and soft enough to satisfactorily admit of drilling and cutting. The metal shall be made without any admixture of cinder iron or other inferior metal, and shall be remelted in a cupola or air furnace.

TESTS OF MATERIALS.

SECTION 9. Specimen bars of the metal used, each being 26 inches long by 2 inches wide and 1 inch thick, shall be made without charge as often as the engineer may direct, and, in default of definite instructions, the contractor shall make and test at least one bar from each heat or run of metal. The bars, when placed flatwise upon supports 24 inches apart and loaded in the center, shall, for pipes 12 inches or less in diameter, support a load of 1,900 pounds and show a deflection of not less than 0.30 inch before breaking; and for pipes of sizes larger than 12 inches, they shall support a load of 2,000 pounds and show a deflection of not less than 0.32 inch. The contractor shall have the right to make and break three bars from each heat or run of metal, and the test shall be based upon the average results of the three bars. Should the dimensions of the bars differ from those above given, a proper allowance therefor shall be made in the results of the tests.

CASTING OF PIPES.

SECTION 10. The straight pipes shall be cast in dry sand molds in a vertical position. Pipes 16 inches or less in diameter

shall be cast with the hub end up or down, as specified in the proposal. Pipes 18 inches or more in diameter shall be cast with the hub end down.

The pipes shall not be stripped or taken from the pit while showing color of heat, but shall be left in the flasks for a sufficient length of time to prevent unequal contraction by subsequent exposure.

QUALITY OF CASTINGS.

SECTION 11. The pipes and special castings shall be smooth, free from scales, lumps, blisters, sand holes and defects of every nature which unfit them for the use for which they are intended. No plugging or filling will be allowed.

CLEANING AND INSPECTION.

SECTION 12. All pipes and special castings shall be thoroughly cleaned and subjected to a careful hammer inspection. No casting shall be coated unless entirely clean and free from rust, and approved in these respects by the engineer immediately before being dipped.

COATING.

SECTION 13. Every pipe and special casting shall be coated inside and out with coal-tar pitch varnish. The varnish shall be made from coal tar. To this material sufficient oil shall be added to make a smooth coating, tough and tenacious when cold, and not brittle nor with any tendency to scale off.

Each casting shall be heated to a temperature of 300° F. immediately before it is dipped, and shall possess not less than this temperature at the time it is put in the vat. The ovens in which the pipes are heated shall be so arranged that all portions of the pipe shall be heated to an even temperature. Each casting shall remain in the bath at least five minutes.

The varnish shall be heated to a temperature of 300° F. (or less if the engineer shall so order), and shall be maintained at this temperature during the time the casting is immersed.

Fresh pitch and oil shall be added when necessary to keep the mixture at the proper consistency, and the vat shall be emptied

of its contents and refilled with fresh pitch when deemed necessary by the engineer. After being coated, the pipes shall be carefully drained of the surplus varnish. Any pipe or special casting that is to be re-coated shall first be thoroughly scraped and cleaned.

HYDROSTATIC TEST.

SECTION 14. When the coating has become hard, the straight pipes shall be subjected to a proof by hydrostatic pressure and, if required by the engineer, they shall also be subjected to a hammer test under this pressure.

The pressure to which the different sizes and classes of pipes shall be subjected are as follows:

	20-Inch Diameter and Larger, lbs. per sq. in.	Less than 20-Inch Diameter, lbs. per sq. in.
Class A pipe	150	300
Class B pipe	200	300
Class C pipe	250	300
Class D pipe	300	300

WEIGHING.

SECTION 15. The pipes and special castings shall be weighed for payment under the supervision of the engineer after the application of the coal-tar pitch varnish. If desired by the engineer the pipes and special castings shall be weighed after their delivery, and the weights so ascertained shall be used in the final settlement, provided such weighing is done by a legalized weighmaster. Bids shall be submitted and a final settlement made up on the basis of a ton of 2,000 pounds.

CONTRACTOR TO FURNISH MEN AND MATERIALS.

SECTION 16. The contractor shall provide all tools, testing machines, materials and men necessary for the required testing, inspection and weighing at the foundry of the pipes and special castings; and, should the purchaser have no inspector at the works, the contractor shall, if required by the engineer, furnish a sworn

statement that all of the tests have been made as specified, this statement to contain the results of the tests upon the test bars.

POWER OF ENGINEER TO INSPECT.

SECTION 17. The engineer shall be at liberty at all times to inspect the material at the foundry, and the molding, casting and coating of the pipes and special castings. The forms, sizes, uniformity and conditions of all pipes and other castings herein referred to shall be subject to his inspection and approval, and he may reject, without proving, any pipes or other casting which is not in conformity with the specifications or drawings.

INSPECTOR TO REPORT.

SECTION 18. The inspector at the foundry shall report daily to the foundry office all pipes and special castings rejected, with the causes for rejection.

CASTINGS TO BE DELIVERED SOUND AND PERFECT.

SECTION 19. All the pipes and other castings must be delivered in all respects sound and conformable to these specifications. The inspection shall not relieve the contractor of any of his obligations in this respect, and any defective pipe or other castings which may have passed the engineer at the works or elsewhere shall be at all times liable to rejection when discovered until the final completion and adjustment of the contract, provided, however, that the contractor shall not be held liable for pipes or special castings found to be cracked after they have been accepted at the agreed point of delivery. Care shall be taken in handling the pipes not to injure the coating, and no pipes or other material of any kind shall be placed in the pipes during transportation or at any time after they receive the coating.

DEFINITION OF THE WORD "ENGINEER."

SECTION 20. Wherever the word "engineer" is used herein, it shall be understood to refer to the engineer or inspector acting for the purchaser and to his properly authorized agents, limited by the particular duties intrusted to them.

AMERICAN SOCIETY FOR TESTING MATERIALS

PHILADELPHIA, PA., U. S. A.

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INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.

STANDARD SPECIFICATIONS FOR LOCOMOTIVE CYLINDERS.

ADOPTED NOVEMBER 15, 1904.

Process of Manufacture.

1. Locomotive cylinders shall be made from good quality of close-grained gray iron cast in a dry sand mold.

Chemical Properties.

2. Drillings taken from test pieces cast as hereafter mentioned shall conform to the following limits in chemical composition:

Silicon	from 1.25 to	1.75	per cent
Phosphorus	not over	0.9	"
Sulphur	"	0.10	"

Physical Properties.

3. The minimum physical qualities for cylinder iron shall be as follows:

The "Arbitration Test Bar," $1\frac{1}{4}$ inches in diameter, with supports 12 inches apart, shall have a transverse strength not less than 3,000 pounds, centrally applied, and a deflection not less than 0.10 inch.

Test Pieces and Methods of Testing.

4. The standard test piece shall be $1\frac{1}{4}$ inches in diameter, about 14 inches long, cast on end in dry sand. The drillings for analysis shall be taken from this test piece, but in case of rejection the manufacturer shall have option of analyzing drillings from the bore of the cylinder, upon which analysis the acceptance or rejection of the cylinder shall be based.

One test piece for each cylinder shall be required.

Character of Castings.

5. Castings shall be smooth, well cleaned, free from blowholes, shrinkage cracks or other defects, and must finish to blue-print size.

Each cylinder shall have cast on each side of saddle, the manufacturer's mark, serial number, date made and mark showing order number.

Inspection.

6. The inspector representing the purchaser shall have all reasonable facilities afforded to him by the manufacturer to satisfy himself that the finished material is furnished in accordance with these specifications. All tests and inspections shall be made at the place of the manufacturer.

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STANDARD SPECIFICATIONS FOR CAST-IRON CAR WHEELS.

ADOPTED SEPTEMBER 1, 1905.

Chemical Properties.

The wheels furnished under this specification must be made from the best materials, and in accordance with the best foundry methods. The following pattern analysis is given for information, as representing the chemical properties of a good cast-iron wheel. Successful wheels, varying in some of the constituents quite considerably from the figures given, may be made:

Total carbon	3.50 per cent.
Graphitic carbon	2.90 "
Combined carbon	0.60 "
Silicon	0.70 "
Manganese	0.40 "
Phosphorus	0.50 "
Sulphur	0.08 "

1. Wheels will be inspected and tested at the place of manufacture.

2. All wheels must conform in general design and in measurements to drawings, which will be furnished, and any departure from the standard drawing must be by special permission in writing, and manufacturers wishing to deviate from the standard dimensions must submit duplicate drawings showing the proposed changes, which must be approved.

Drop Tests.

3. The following table gives data as to weight and tests of various kinds of wheels for different kinds of cars and service:

Wheel		33-inch diameter Frgt. and Pass. cars.			36-inch diameter.	
Kind of service		60,000 lbs. capacity and less	70,000 lbs. capacity.	100,000 lbs capacity.	Passenger Cars.	Locomotive Tenders
Number		1	2	3	4	5
Weight	Desired	600	650	700	700 lbs.	750 lbs.
	Variation	Two per cent. either way.				
Height of drop, ft.		9	12	12	12	12
Number of blows		10	10	12	12	14

Marking. 4. Each wheel must have plainly cast on the outside plate the name of the maker and place of manufacture. Each wheel must also have cast on the inside double plate the date of casting and a serial foundry number. The manufacturer must also provide for the guarantee mark, if so required by the contract. No wheel bearing a duplicate number, or a number which has once been passed upon, will be considered. Numbers of wheels once rejected will remain unfilled. No wheel bearing an indistinct number or date, or any evidence of an altered or defaced number will be considered.

Measures. 5. All wheels offered for inspection must have been measured with a standard tape measure and must have the shrinkage number stenciled in plain figures on the inside of the wheel. The standard tape measure must correspond in form and construction to the "Wheel Circumference Measure" established by the Master Car Builders' Association in 1900. The nomenclature of that measure need not, however, be followed, it being sufficient if the graduating marks indicating tape sizes are one-eighth of an inch apart. Any convenient method of showing the shrinkage or stencil number may be employed. Experience shows that standard tape measures elongate a little with use, and it is essential to have them frequently compared and rectified. When ready for inspection, the wheels must be arranged in rows according to shrinkage numbers, all wheels of the same date being grouped together. Wheels bearing dates more than thirty days prior to the date of inspection will not be accepted for test, except by permission. For any single inspection and test only wheels having

three consecutive shrinkage or stencil numbers will be considered. The manufacturer will, of course, decide what three shrinkage or stencil numbers he will submit in any given lot of 103 wheels offered, and the same three shrinkage or stencil numbers need not be offered each time.

Finish.

6. The body of the wheels must be smooth and free from slag and blowholes, and the hubs must be solid. Wheels will not be rejected because of drawing around the center core. The tread and throat of the wheels must be smooth, free from deep and irregular wrinkles, slag, sand wash, chill cracks or swollen rims, and be free from any evidence of hollow rims, and the throat and thread must be practically free from sweat.

Material and Chill.

7. Wheels tested must show soft, clean, gray iron, free from defects, such as holes containing slag or dirt more than one-quarter of an inch in diameter, or clusters of such holes, honeycombing of iron in the hub, white iron in the plates or hub, or clear white iron around the anchors of chaplets at a greater distance than one-half of an inch in any direction. The depth of the clear white iron must not exceed seven-eighths of an inch at the throat and one inch at the middle of the tread, nor must it be less than three-eighths of an inch at the throat or any part of the tread. The blending of the white iron with the gray iron behind must be without any distinct line of demarcation, and the iron must not have a mottled appearance in any part of the wheel at a greater distance than one and five-eighths inches from the tread or throat. The depth of chill will be determined by inspection of the three test wheels described below, all test wheels being broken for this purpose, if necessary. If one only of the three test wheels fails in limits of chill, all the lot under test of the same shrinkage or stencil number will be rejected and the test will be regarded as finished so far as this lot of 103 wheels is concerned. The manufacturer may, however, offer the wheels of the other two shrinkage or stencil numbers, provided they are acceptable in other respects as constituents of another 103 wheels for a subsequent test. If two of the three test wheels fail in limits of chill, the wheels in the lot of 103 of the same shrinkage or stencil number as these two wheels will be rejected, and, as before, the test will be regarded as finished so far as this lot of 103 wheels is concerned. The manufacturer may, however, offer the wheels of the third shrinkage or

stencil number, provided they are acceptable in other respects, as constituents of another 103 wheels for a subsequent test. If all three test wheels fail in limits of chill, of course the whole hundred will be rejected.

Inspection and Shipping.

8. The manufacturer must notify when he is ready to ship not less than 100 wheels; must await the arrival of the inspector; must have a car, or cars, ready to be loaded with the wheels, and must furnish facilities and labor to enable the inspector to inspect, test, load and ship the wheels promptly. Wheels offered for inspection must not be covered with any substance which will hide defects.

9. A hundred or more wheels being ready for test, the inspector will make a list of the wheel numbers, at the same time examining each wheel for defects. Any wheels which fail to conform to specifications by reason of defects must be laid aside, and such wheels will not be accepted for shipment. As individual wheels are rejected, others of the proper shrinkage, or stencil number, may be offered to keep the number good.

Retaping.

10. The inspector will retape not less than 10 per cent of the wheels offered for test, and if he finds any showing wrong tape-marking, he will tape the whole lot and require them to be restenciled, at the same time having the old stencil marks obliterated. He will weigh and make check measurements of at least 10 per cent. of the wheels offered for test, and if any of these wheels fail to conform to the specification, he will weigh and measure the whole lot, refusing to accept for shipment any wheels which fail in these respects.

Drop Tests.

11. Experience indicates that wheels with higher shrinkage or lower stencil numbers are more apt to fail on thermal test; more apt to fail on drop test, and more apt to exceed the maximum allowable chill than those with higher stencil or lower shrinkage numbers; while, on the other hand, wheels with higher stencil or lower shrinkage numbers are more apt to be deficient in chill. For each 103 wheels apparently acceptable, the inspector will select three wheels for test—one from each of the three shrinkage or stencil numbers offered. One of these wheels chosen for this purpose by the inspector must be tested by drop test as follows: The wheel must be placed flange downward in an anvil block weighing not less than 1,700 pounds, set on rubble masonry two

feet deep and having three supports not more than five inches wide for the flange of the wheel to rest on. It must be struck centrally upon the hub by a weight of 200 pounds, falling from a height as shown in the table in Section 3. The end of the falling weight must be flat, so as to strike fairly on the hub, and when by wear the bottom of the weight assumes a round or conical form, it must be replaced. The machine for making this test is shown on drawings which will be furnished. Should the wheel stand without breaking in two or more pieces, the number of blows, shown in the above table, the one hundred wheels represented by it will be considered satisfactory as to this test. Should it fail, the whole hundred will be rejected.

Thermal Test.

12. The other two test wheels must be tested as follows: The wheels must be laid flange down in the sand, and a channelway one and one-half inches in width at the center of the tread and four inches deep must be molded with green sand around the wheel. The clean tread of the wheel must form one side of this channelway, and the clean flange must form as much of the bottom as its width will cover. The channelway must then be filled to the top from one ladle with molten cast iron, which must be poured directly into the channelway without previous cooling or stirring, and this iron must be so hot, when poured, that the ring which is formed when the metal is cold shall be solid or free from wrinkles or layers. Iron at this temperature will usually cut a hole at the point of impact with the flange. In order to avoid spitting during the pouring, the tread and inside of the flange during the thermal test should be covered with a coat of shellac; wheels which are wet or which have been exposed to snow or frost may be warmed sufficiently to dry them or remove the frost before testing, but under no circumstances must the thermal test be applied to a wheel that in any part feels warm to the hand. The time when pouring ceases must be noted, and two minutes later an examination of the wheel under test must be made. If the wheel is found broken in pieces, or if any crack in the plates extends through or into the tread, the test wheel will be regarded as having failed. If both wheels stand, the whole hundred will be accepted as to this test. If both fail, the whole hundred will be rejected. If one only of the thermal test wheels fails, all of the lot under test of the same shrinkage or stencil number will be

rejected, and the test will be regarded as finished, so far as this lot of wheels is concerned. The manufacturer may, however, offer the wheels of the other two shrinkage or stencil numbers, provided they are acceptable in other respects, as constituents of another 103 wheels for a subsequent test.

Storing and Shipping.

13. All wheels which pass inspection and test will be regarded as accepted, and may be either shipped or stored for future shipment, as arranged. It is desired that shipments should be, as far as possible, in lots of 100 wheels. In all cases the inspector must witness the shipment, and he must give, in his report the numbers of all wheels inspected and the disposition made of them.

Rejections.

14. Individual wheels will be considered to have failed and will not be accepted or further considered, which,

First. Do not conform to standard design and measurement.

Second. Are under or over weight.

Third. Have the physical defects described in Section 6.

Rejections.

15. Each 103 wheels submitted for test will be considered to have failed and will not be accepted or considered further, if,

First. The test wheels do not conform to Section 7, especially as to limits of white iron in the throat and tread and around chaplets.

Second. One of the test wheels does not stand the drop test as described in Section 11.

Third. Both of the two test wheels do not stand the thermal test as described in Section 12.

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STANDARD SPECIFICATIONS FOR GRAY-IRON CASTINGS.

ADOPTED SEPTEMBER 1, 1905.

Process of Manufacture.

1. Unless furnace iron is specified, all gray castings are understood to be made by the cupola process.

Chemical Properties.

2. The sulphur contents to be as follows:

Light castings	not over 0.08 per cent.
Medium castings	" 0.10 "
Heavy casting	" 0.12 "

Classification.

3. In dividing castings into light, medium and heavy classes, the following standards have been adopted:

Castings having any section less than ½-inch thick shall be known as *light castings*.

Castings in which no section is less than 2 inches thick shall be known as *heavy castings*.

Medium castings are those not included in the above classification.

Physical Properties.

4. *Transverse Test.* The minimum breaking strength of the "Arbitration Bar" under transverse load shall be not under:

Light castings	2,500 lbs.
Medium castings	2,900 "
Heavy castings	3,300 "

In no case shall the deflection be under 0.10 inch.

Tensile Test. Where specified, this shall not run less than:

Light castings	18,000 lbs. per sq. in.
Medium castings	21,000 " " "
Heavy castings	24,000 " " "

Arbitration Bar.

5. The quality of the iron going into castings under specification shall be determined by means of the "Arbitration Bar." This is a bar 1¼ inches in diameter and 15 inches long. It shall be prepared as stated further on and tested transversely. The tensile test is not recommended, but in case it is called for, the bar as shown in Fig. 1, and turned up from any of the broken pieces of the transverse test shall be used. The expense of the tensile test shall fall on the purchaser.

Number of Test Bars.

6. Two sets of two bars shall be cast from each heat, one set from the first and the other set from the last iron going into the castings. Where the heat exceeds twenty tons, an additional set

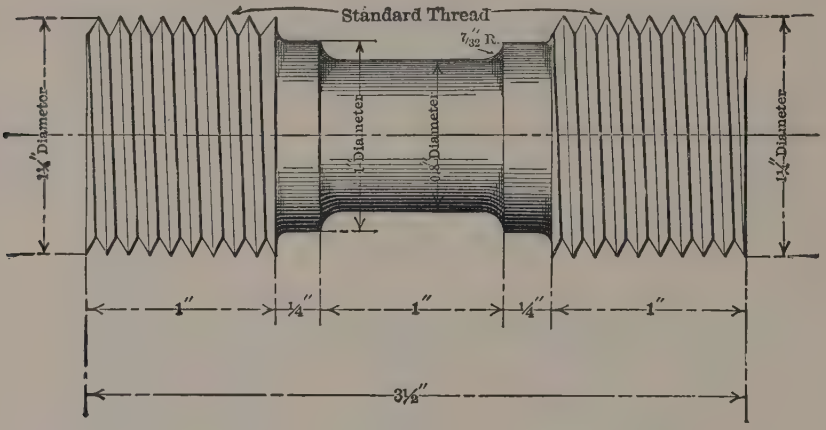

FIG. 1.—ARBITRATION TEST BAR. TENSILE TEST PIECE.

o two bars shall be cast for each twenty tons or fraction thereof above this amount. In case of a change of mixture during the heat, one set of two bars shall also be cast for every mixture other than the regular one. Each set of two bars is to go into a single mold. The bars shall not be rumbled or otherwise treated, being simply brushed off before testing.

Method of Testing.

7. The transverse test shall be made on all the bars cast, with supports 12 inches apart, load applied at the middle, and the deflection at rupture noted. One bar of every two of each set made must fulfil the requirements to permit acceptance of the castings represented.

8. The mold for the bars is shown in Fig. 2. The bottom of the bar is $\frac{1}{16}$ inch smaller in diameter than the top, to allow for draft and for the strain of pouring. The pattern shall not be rapped before withdrawing. The flask is to be rammed up with green molding sand, a little damper than usual, well mixed and

Mold for Test Bar.

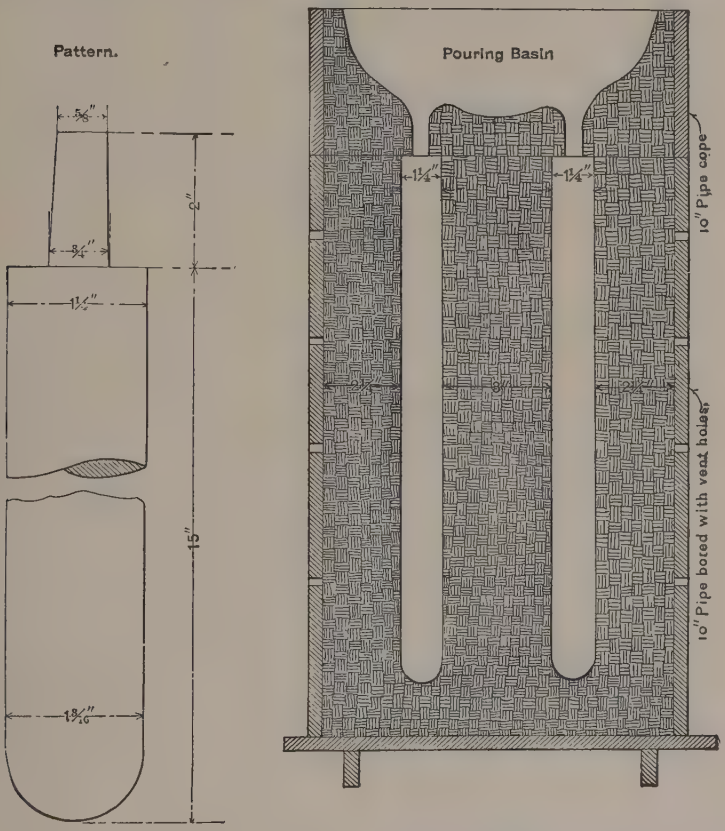

FIG. 2.—MOLD FOR ARBITRATION TEST BAR.

put through a No. 8 sieve, with a mixture of one to twelve bituminous facing. The mold shall be rammed evenly and fairly hard, thoroughly dried and not cast until it is cold. The test bar shall not be removed from the mold until cold enough to be handled.

9. The rate of application of the load shall be from 20 to 40 seconds for a deflection of 0.10 inch.

Speed of Testing.

Samples for Analysis.

10. Borings from the broken pieces of the "Arbitration Bar" shall be used for the sulphur determinations. One determination for each mold made shall be required. In case of dispute, the standards of the American Foundrymen's Association shall be used for comparison.

Finish.

11. Castings shall be true to pattern, free from cracks, flaws and excessive shrinkage. In other respects they shall conform to whatever points may be specially agreed upon.

Inspection.

12. The inspector shall have reasonable facilities afforded him by the manufacturer to satisfy him that the finished material is furnished in accordance with these specifications. All tests and inspections shall, as far as possible, be made at the place of manufacture prior to shipment.

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STANDARD SPECIFICATIONS FOR MALLEABLE CASTINGS.

ADOPTED NOVEMBER 15, 1904.

Process of Manufacture.

1. Malleable iron castings may be made by the open-hearth, air furnace, or cupola process. Cupola iron, however, is not recommended for heavy nor for important castings.

Chemical Properties.

2. Castings for which physical requirements are specified shall not contain over 0.06 sulphur nor over 0.225 phosphorus.

Physical Properties.

3. *Standard Test Bar.* This bar shall be 1 inch square and 14 inches long, without chills and with ends left perfectly free in the mold. Three shall be cast in one mold, heavy risers insuring sound bars. Where the full heat goes into castings which are subject to specification, one mold shall be poured two minutes after tapping into the first ladle, and another mold from the last iron of the heat. Molds shall be suitably stamped to insure identification of the bars, the bars being annealed with the castings. Where only a partial heat is required for the work in hand, one mold should be cast from the first ladle used and another after the required iron has been tapped.

(*a*) Of the three test bars from the two molds required for each heat, one shall be tested for tensile strength and elongation, the other for transverse strength and deflection. The other remaining bar is reserved for either the transverse or tensile test, in case of the failure of the two other bars to come up to requirements. The halves of the bars broken transversely may also be used for the tensile test.

(*b*) Failure to reach the required limit for the tensile strength with elongation, as also the transverse strength with deflection, on the part of at least one test, rejects the castings from that heat.

4. *Tensile Test.* The tensile strength of a standard test bar for castings under specification shall not be less than 40,000 pounds per square inch. The elongation measured in 2 inches shall not be less than $2\frac{1}{2}$ per cent.

5. *Transverse Test.* The transverse strength of a standard test bar, on supports 12 inches apart, pressure being applied at center, shall not be less than 3,000 pounds, deflection being at least $\frac{1}{2}$ inch.

Test Lugs. 6. Castings of special design or of special importance may be provided with suitable test lugs at the option of the inspector. At least one of these lugs shall be left on the casting for his inspection upon his request therefor.

Annealing. 7. Malleable castings shall neither be "over" nor "under" annealed. They must have received their full heat in the oven at least sixty hours after reaching that temperature.

The "saggers" shall not be dumped until the contents shall at least be "black hot."

Finish. 8. Castings shall be true to pattern, free from blemishes, scale or shrinkage cracks. A variation of $\frac{1}{16}$ inch per foot shall be permissible. Founders shall not be held responsible for defects due to irregular cross sections and unevenly distributed metal.

Inspection. 9. The inspector representing the purchaser shall have all reasonable facilities given him by the founder to satisfy him that the finished material is furnished in accordance with these specifications. All tests and inspections shall be made prior to shipment.

STANDARD SPECIFICATIONS

FOR

LOCOMOTIVE MATERIALS.

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1. Annealed Steel Forgings 250
2. Steel Shapes, Universal Mill Plates, and Bars 254
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The following standard specifications, not designed specifically for locomotive materials, are also applicable to locomotives.

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7. Boiler Rivet Steel 157
8. Locomotive Cylinders 235

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STANDARD SPECIFICATIONS FOR LOCOMOTIVE MATERIALS.

ANNEALED STEEL FORGINGS.

ADOPTED JUNE 1, 1912.

I. MANUFACTURE.

Process. 1. The steel shall be made by the open-hearth process.

Heat Treatment. 2. The forgings shall be allowed to become cold after forging; shall then be reheated to the proper temperature to refine the grain, and allowed to cool slowly.

II. CHEMICAL PROPERTIES AND TESTS.

Chemical Composition. 3. The steel shall conform to the following requirements as to chemical composition:

Manganese	not over 0.70 per cent
Phosphorus	" " 0.05 "
Sulphur	" " 0.05 "

Ladle Analyses. 4. To determine whether the material conforms to the requirements specified in Section 3, an analysis shall be made by the manufacturer from a test ingot taken during the pouring

of each melt. A copy of this analysis shall be given to the purchaser or his representative.

Check Analyses.

5. A check analysis may be made by the purchaser from one forging representing each melt, and this analysis shall conform to the requirements specified in Section 3. Drillings for analysis may be taken from the forging or from the full-size prolongation of the same, parallel to the axis, at any point one-half the distance from the center to the surface; or from a broken tension test specimen.

III. PHYSICAL PROPERTIES AND TESTS.

Tension Tests.

6. (*a*) The steel shall conform to the following minimum requirements as to tensile properties:

Tensile strength, lb. per sq. in.....	80 000
Yield point, " "	0.5 tens. str.
Elongation in 2 in., per cent.....	22
Reduction of area, "	35

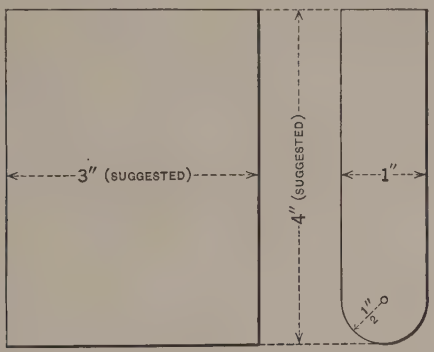

FIG. 1.

(*b*) The yield point shall be determined by the drop of the beam of the testing machine.

Bend Tests.

7. (*a*) The test specimen shall bend cold through 180 deg. around a 1-in. flat mandrel having a rounded edge of $\frac{1}{2}$-in. radius, without fracture on the outside of the bent portion. The form and suggested dimensions of the mandrel are shown in Fig. 1.

(*b*) Bend tests may be made by pressure or by blows.

Test Specimens.

8. (*a*) Tension and bend test specimens may be taken from the forging or from the full-size prolongation of the same

The axis of the specimen shall be located at any point one-half the distance from the center to the surface and shall be parallel to the axis of the forging. When the specimens are taken with a hollow drill from the end of the forging, as in the case of driving axles, the hole made by the drill shall not be more than 2 in. in diameter nor more than $4\frac{1}{2}$ in. deep.

(*b*) Tension test specimens shall be of the form and dimensions shown in Fig. 2.

Bend test specimens shall be $\frac{1}{2}$ in. square in section, and shall not exceed 6 in. in length.

Number of Tests. 9. (*a*) One tension and one bend test shall be made from each melt.

Retests. 10. If the results of the physical tests of any lot of forgings do not conform to the requirements specified in Sections

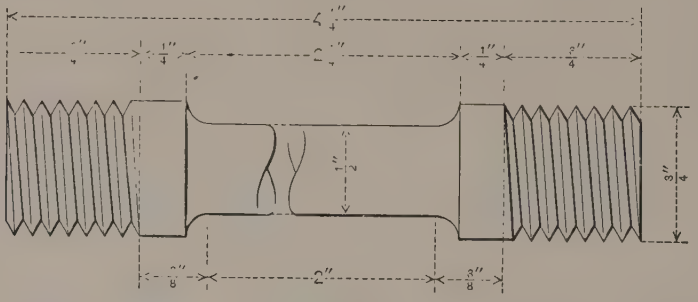

FIG. 2.

6 and 7, the manufacturer may re-anneal each such lot. Retests shall then be taken by the purchaser, and these shall govern its acceptance or rejection.

IV. WORKMANSHIP AND FINISH.

Workmanship. 11. The forgings shall conform in sizes and shapes to the requirements given on the order of the purchaser or the drawing sent with it. In centering, 60-deg. centers with clearance drilled at point shall be used.

Finish. 12. The finished forgings shall be free from injurious seams, slivers, flaws, and other defects, and shall have a workmanlike finish.

V. MARKING.

13. The name or brand of the manufacturer and the melt number shall be legibly stamped on one end of each forging. **Marking.**

VI. INSPECTION AND REJECTION.

14. (*a*) The inspector representing the purchaser shall have free entry, at all times while work on the contract of the purchaser is being performed, to all parts of the manufacturer's works which concern the manufacture of the material ordered. The manufacturer shall afford the inspector, free of cost, all reasonable facilities to satisfy him that the forgings are being furnished in accordance with these specifications. Tests and inspection at the place of manufacture shall be made prior to shipment. **Inspection.**

(*b*) The purchaser may make the tests to govern the acceptance or rejection of material in his own laboratory or elsewhere. Such tests, however, shall be made at the expense of the purchaser.

(*c*) All tests and inspection shall be so conducted as not to interfere unnecessarily with the operation of the works.

15. Unless otherwise arranged, any rejection based on tests made in accordance with Section 14(*b*) shall be reported within five working days from the receipt of samples. **Rejection**

16. Samples tested in accordance with Section 14(*b*), which represent rejected material, shall be preserved for two weeks from the date of the test report. In case of dissatisfaction with the results of the tests, the manufacturer may make claim for a rehearing within that time. **Rehearing.**

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STANDARD SPECIFICATIONS

FOR

LOCOMOTIVE MATERIALS.

STEEL SHAPES, UNIVERSAL MILL PLATES, AND BARS.

ADOPTED JUNE 1, 1912.

I. MANUFACTURE.

Process.

1. The steel shall be made by the open-hearth process.

II. CHEMICAL PROPERTIES AND TESTS.

Chemical Composition.

2. The steel shall conform to the following requirements as to chemical composition:

Phosphorus	not over 0.05 per cent
Sulphur	" " 0 05 "

Ladle Analyses.

3. To determine whether the material conforms to the requirements specified in Section 2, an analysis shall be made by the manufacturer from a test ingot taken during the pouring of each melt. A copy of this analysis shall be given to the purchaser or his representative.

Check Analyses.

4. A check analysis may be made by the purchaser from finished material representing each melt, and this analysis shall conform to the requirements specified in Section 2.

III. PHYSICAL PROPERTIES AND TESTS.

Tension Tests.

5. (*a*) The steel shall conform to the following requirements as to tensile properties:

Tensile strength, lb. per sq. in.	55 000 – 65 000
Yield point, min., " "	0.5 tens. str.
Elongation in 8 in., min., per cent (See Section 6)	$\frac{1\,500\,000}{\text{Tens. str.}}$

(*b*) The yield point shall be determined by the drop of the beam of the testing machine.

Modifications in Elongation.

6. (*a*) For material over $\frac{3}{4}$ in. in thickness, a deduction of 1 from the percentage of elongation specified in Section 5 shall be made for each increase of $\frac{1}{8}$ in. in thickness above $\frac{3}{4}$ in., to a minimum of 20 per cent.

(*b*) For material $\frac{1}{4}$ in. or under in thickness, the elongation shall be measured on a gage length of 24 times the thickness of the specimen.

Bend Tests.

7. (*a*) The test specimen shall bend cold through 180 deg. without fracture on the outside of the bent portion, as follows: For material under $\frac{3}{4}$ in. in thickness, flat on itself; for material $\frac{3}{4}$ to $1\frac{1}{4}$ in. in thickness, around a pin the diameter of which is equal to $1\frac{1}{2}$ times the thickness of the specimen; and for material over $1\frac{1}{4}$ in. in thickness, around a pin the diameter of which is equal to twice the thickness of the specimen.

(*b*) Bend tests may be made by pressure or by blows.

Tests of Angles.

8. Angles $\frac{3}{4}$ in. or under in thickness shall open flat, and angles $\frac{1}{2}$ in. or under in thickness shall bend shut, cold, under the blows of a hammer without fracture. This test shall be made only when required by the inspector.

Test Specimens.

9. (*a*) Tension and bend test specimens shall be taken from the finished product, and shall be of the full thickness of material as rolled.

(*b*) Tension test specimens may be of the form and dimensions shown in Fig. 1; or with both edges parallel; or they may be turned to a diameter of $\frac{3}{4}$ in. for a length of at least 9 in., with enlarged ends.

The sheared edges of bend test specimens shall be milled or planed.

Number of Tests.

10. (*a*) At least one tension and one bend test shall be made from each melt, except that shapes less than 1 sq. in. in section, and bars less than $\frac{1}{2}$ sq. in. in section, need not be subjected to a tension test. If material from one melt differs $\frac{3}{8}$ in. or over in thickness, tests shall be made from both the thickest and the thinnest material rolled.

(*b*) If any test specimen develops flaws, or if a tension test specimen breaks outside the middle third of the gage length, it may be discarded and another specimen substituted.

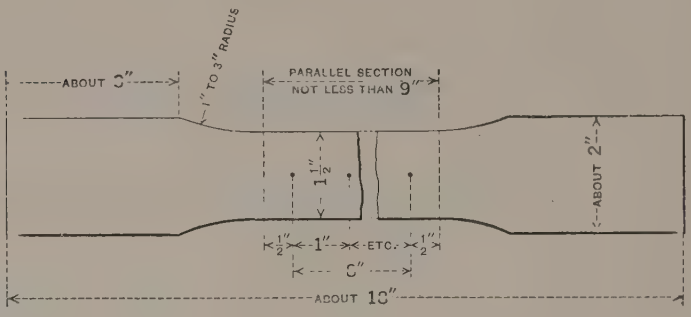

FIG. 1.

IV. PERMISSIBLE VARIATIONS IN WEIGHT.

Permissible Variations.

11. The cross-section or weight of each piece shall not vary more than 2.5 per cent from that specified.

V. FINISH.

Finish.

12. The finished material shall be free from injurious seams, slivers, flaws, and other defects, and shall have a workmanlike finish.

VI. MARKING.

Marking.

13. The melt number shall be legibly stamped or rolled on each piece. The size and order number shall be legibly marked on each piece with white lead.

VII. INSPECTION.

Inspection.

14. (*a*) The inspector representing the purchaser shall have free entry, at all times while work on the contract of the pur-

chaser is being performed, to all parts of the manufacturer's works which concern the manufacture of the material ordered. The manufacturer shall afford the inspector, free of cost, all reasonable facilities to satisfy him that the material is being furnished in accordance with these specifications. All tests and inspection shall be made at the place of manufacture prior to shipment, except as provided for in Section 14(*b*), and shall be so conducted as not to interfere unnecessarily with the operation of the works.

(*b*) At the option of the purchaser, material on an order of 1 ton or less may be shipped on inspection by the manufacturer.

15. Defective material inspected in accordance with Section 14 (*b*) will be rejected, and the manufacturer shall be notified. **Rejection.**

AMERICAN SOCIETY FOR TESTING MATERIALS

PHILADELPHIA, PA., U. S. A.

AFFILIATED WITH THE

INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.

STANDARD SPECIFICATIONS FOR LOCOMOTIVE MATERIALS.

LAP-WELDED AND SEAMLESS STEEL BOILER TUBES AND SAFE ENDS, 2½ IN. DIAMETER AND UNDER.

ADOPTED JUNE 1, 1912.

I. MANUFACTURE.

Process.

1. The steel shall be made by the open-hearth process.

II. CHEMICAL PROPERTIES AND TESTS.

Chemical Composition.

2. The steel shall conform to the following requirements as to chemical composition:

Carbon	not over 0.15 per cent
Manganese	0.30 – 0.50 "
Phosphorus	not over 0.04 "
Sulphur	" " 0.045 "

Chemical Analyses.

3. (*a*) Analyses of two tubes in each lot of 250 or less shall be made, and these analyses shall conform to the requirements specified in Section 2. Drillings for analyses shall be taken from several points around each tube.

(*b*) If the analysis of only one tube does not conform to the requirements specified, analyses of two additional tubes from the same lot shall be made and each of these shall conform to the requirements specified.

III. PHYSICAL PROPERTIES AND TESTS.

Flange Tests.

4. A test specimen not less than 4 in. in length shall have a flange $\frac{3}{8}$ in. wide turned over at right angles to the body of the tube without showing cracks or flaws.

Flattening Tests

5. A test specimen 4 in. in length shall stand hammering flat until the inside walls are in contact, without cracking at the edges or elsewhere. For lap-welded tubes, care shall be taken that the weld is not located at the point of maximum bending.

Crush Tests.

6. A test specimen $2\frac{1}{2}$ in. in length shall stand crushing flat longitudinally without showing cracks or flaws.

Hydraulic Tests.

7. Tubes of Nos. 9, 10, and 11 B.w.g. shall stand an internal hydraulic pressure of 1000 lb. per sq. in., and tubes of Nos. 12 and 13 B.w.g. an internal hydraulic pressure of 900 lb. per sq. in.

Test Specimens.

8. (*a*) Test specimens shall consist of sections cut from a tube. They shall be smooth on the ends and free from burrs.

(*b*) All specimens shall be tested cold.

Number of Tests.

9. One flange, one flattening, and one crush test shall be made from each of two tubes in each lot of 250 or less. Each tube shall be subjected to the hydraulic test.

Retests.

10. If the results of the physical tests of only one tube do not conform to the requirements specified in Sections 4, 5, or 6, retests of two additional tubes from the same lot shall be made and each of these shall conform to the requirements specified.

IV. STANDARD WEIGHTS.

Standard Weights.

11. The standard weights for tubes of various outside diameters and thicknesses, are as follows:

STANDARD WEIGHTS.

Thickness.		Weight, lb. per ft. of length. Outside Diameter, in.			
Nearest B.w.g.	In.	$1\frac{3}{4}$	2	$2\frac{1}{4}$	$2\frac{1}{2}$
13	0.095	1.68	1.93	2.19	2.44
12	0.110	1.93	2.22	2.51	2.81
11	0.125	2.17	2.50	2.84	3.17
10	0.135	2.33	2.69	3.05	3.41
9	0.150	2.56	2.96	3.36	3.77

Permissible Variations.

12. The weight of the tubes shall not vary more than 5 per cent from that specified in Section 11.

V. WORKMANSHIP AND FINISH.

Workmanship.

13. (*a*) The finished tubes shall be circular within 0.02 in., and the mean outside diameter shall not vary more than 0.015 in. from the size ordered. They shall not be shorter than the length ordered, but may exceed it by 0.125 in.

(*b*) For lap-welded tubes, the thickness at any point shall not vary more than 0.01 in. from that specified, except at the weld, where an additional thickness of 0.015 in. shall be allowed.

For seamless tubes, the thickness at any point shall not vary more than 10 per cent from that specified.

Finish.

14. The finished tubes shall be free from injurious seams, flaws, or cracks, and shall have a workmanlike finish. They shall be free from kinks, bends, and buckles.

VI. MARKING.

Marking

15. The name or brand of the manufacturer, and "Tested at 1000 lb." for Nos. 9, 10, and 11 B.w.g., or "Tested at 900 lb." for Nos. 12 and 13 B.w.g., shall be legibly stenciled in white on each tube.

VII. INSPECTION AND REJECTION.

Inspection.

16. The inspector representing the purchaser shall have free entry, at all times while work on the contract of the purchaser is being performed, to all parts of the manufacturer's works which concern the manufacture of the material ordered. The manufacturer shall afford the inspector, free of cost, all reasonable facilities to satisfy him that the material is being furnished in accordance with these specifications. All tests and inspection shall be made at the place of manufacture prior to shipment, and shall be so conducted as not to interfere unnecessarily with the operation of the works.

Rejection.

17. Tubes when inserted in the boiler shall stand expanding and beading without showing cracks or flaws, or opening at the weld. Tubes which fail in this manner will be rejected, and the manufacturer shall be notified.

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STANDARD SPECIFICATIONS FOR LOCOMOTIVE MATERIALS

STAYBOLT IRON.

ADOPTED JUNE 1, 1912.

I. MANUFACTURE.

Process.

1. The iron shall be rolled from a bloom or boxpile, made wholly from puddled iron or knobbled charcoal iron. The puddle mixture and the component parts of the bloom or boxpile shall be free from any admixture of iron scrap or steel.

Definition of Terms.

2. (*a*) *Bloom.*—A bloom is a solid mass of iron that has been hammered into a convenient size for rolling.

(*b*) *Boxpile.*—A boxpile is a pile, the sides, top and bottom of which are formed by four flat bars and the interior of which consists of a number of small bars the full length of the pile.

(*c*) *Iron Scrap.*—This term applies only to foreign or bought scrap and does not include local mill products free from foreign or bought scrap.

II. PHYSICAL PROPERTIES AND TESTS.[1]

Tension Tests.

3. (*a*) The iron shall conform to the following requirements as to tensile properties:

[1] Committee A-2 on Standard Specifications for Wrought Iron, which prepared these specifications for presentation to the Society, desires to call attention to the fact that the vibration test has been omitted from the specifications. While recognizing its importance, the Committee feels that the variations in the results obtained by this test are so great that it is not advisable to include such a requirement in the specifications until it has been carefully standardized. The Committee means to institute further inquiries with the hope of reaching a sound basis for this test in the measurably near future.

Tensile strength, lb. per sq. in.....	49 000 – 53 000
Yield point, min., " "	0.6 tens. str.
Elongation in 8 in., min., per cent.....	30
Reduction of area, " "	48

(*b*) The yield point shall be determined by the drop of the beam of the testing machine. The speed of the cross-head of the machine shall not exceed $1\frac{1}{2}$ in. per minute.

Bend Tests. 4. (*a*) *Cold-bend Tests.*—The test specimen shall bend cold through 180 deg. flat on itself in both directions without fracture on the outside of the bent portion.

(*b*) *Quench-bend Tests.*—The test specimen, when heated to a yellow heat and quenched at once in water the temperature of which is between 80° and 90° F., shall bend through 180 deg. flat on itself without fracture on the outside of the bent portion.

(*c*) *Nick-bend Tests.*—The test specimen, when nicked 25 per cent around with a tool having a 60-deg. cutting edge, to a depth of not less than 8 nor more than 16 per cent of the diameter of the specimen, and broken, shall show a clean fiber entirely free from crystallization.

(*d*) Bend tests may be made by pressure or by blows.

Etch Tests.[1] 5. The cross-section of the test specimen shall be ground or polished, and etched for a sufficient period to develop the structure. This test shall show the material to have been rolled from a bloom or a boxpile, and to be free from steel.

Test Specimens. 6. All test specimens shall be of the full section of material as rolled.

Number of Tests 7. (*a*) Bars of one size shall be sorted into lots of 100 each. Two bars shall be selected at random from each lot or fraction thereof, and tested as specified in Sections 3 and 4; but only one of these bars shall be tested as specified in Section 5.

(*b*) If any test specimen from either of the bars originally selected to represent a lot of material, contains surface defects not visible before testing but visible after testing, or if a tension test specimen breaks outside the middle third of the gage length, one retest from a different bar will be allowed.

[1] A solution of two parts water, one part concentrated hydrochloric acid, and one part concentrated sulphuric acid is recommended for the etch test.

III. PERMISSIBLE VARIATIONS IN GAGE.

Permissible Variations.

8. The bars shall be truly round within 0.01 in., and shall not vary more than 0.005 in. above nor more than 0.01 in. below the specified size.

IV. FINISH.

Finish.

9. The bars shall be smoothly rolled and free from slivers, depressions, seams, crop ends, and evidences of being burnt.

V. MARKING.

Marking.

10. The bars shall be stamped or marked as designated by the purchaser.

VI. INSPECTION AND REJECTION.

Inspection.

11. (*a*) The inspector representing the purchaser shall have free entry, at all times while work on the contract of the purchaser is being performed, to all parts of the manufacturer's works which concern the manufacture of the material ordered. The manufacturer shall afford the inspector, free of cost, all reasonable facilities to satisfy him that the material is being furnished in accordance with these specifications. Tests and inspection at the place of manufacture shall be made prior to shipment.

(*b*) The purchaser may make the tests to govern the acceptance or rejection of material in his own laboratory or elsewhere. Such tests, however, shall be made at the expense of the purchaser.

Rejection.

12. (*a*) If either of the test bars selected to represent a lot does not conform to the requirements specified in Sections 3, 4, 5, and 6, the lot will be rejected.

(*b*) Bars which will not take a clean, sharp thread with dies in fair condition, or which develop defects in forging or machining, will be rejected, and the manufacturer shall be notified.

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STANDARD SPECIFICATIONS FOR LOCOMOTIVE MATERIALS.

LAP-WELDED IRON BOILER TUBES.

ADOPTED JUNE 1, 1912.

I. MANUFACTURE.

Process. 1. The tubes shall be made from knobbled, hammered charcoal iron.

II. PHYSICAL PROPERTIES AND TESTS.

Bend Tests. 2. (*a*) *Quench-bend Tests.*—Strips $\frac{1}{2}$ in. in width by 6 in. in length, planed lengthwise from tubes, when heated to a cherry red and quenched at once in water the temperature of which is 80° F., shall bend in opposite directions at each end, as shown in Fig. 1, without showing cracks or flaws.

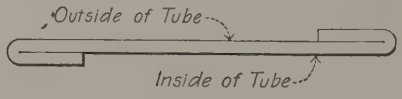

FIG. 1.

(*b*) *Nick-bend Tests.*—Strips $\frac{1}{2}$ in. in width by 6 in. in length, planed lengthwise from tubes, when nicked and broken by light blows, shall show a wholly fibrous fracture.

Expansion Tests. 3. A test specimen 12 in. in length shall be heated for a length of 5 in. to a bright cherry red (1200°–1400° F.) placed in a vertical position, and a smooth tapered steel pin at

blue heat (600°–800° F.) forced into the end of the tube by pressure or by light blows of a 10-lb. hammer. Under this test the tube shall expand to $1\frac{1}{8}$ times its original diameter without splitting or cracking. The pin shall be of tool steel and shall have a taper of $1\frac{1}{2}$ in. per foot of length.

Crush Tests. 4. A test specimen $2\frac{1}{2}$ in. in length shall stand crushing longitudinally to a height of $1\frac{1}{8}$ in. without splitting in either direction and without cracking or opening at the weld.

Hydraulic Tests. 5. Each tube shall stand an internal hydraulic pressure of between 500 and 750 lb. per sq. in.

Etch Tests.[1] 6. In case of doubt as to the quality of material, the following test shall be made to detect the presence of steel. A cross-section of tube shall be turned or ground to a perfectly true surface, polished free from dirt or cracks, and etched until the soft parts are sufficiently dissolved for the iron tube to show a decided ridged surface, with the weld very distinct, while a steel tube would show a homogeneous surface.

Test Specimens. 7. Test specimens shall consist of sections cut from a tube. They shall be smooth on the ends and free from burrs.

Number of Tests. 8. One tube from each lot of 250 or fraction thereof shall be tested as specified in Sections 2, 3, and 4. Each tube shall be tested as specified in Section 5.

Retests. 9. If the results of the tests do not conform to the requirements specified in Sections 2, 3, or 4, retests of two additional tubes from the same lot shall be made and each of these shall conform to the requirements specified.

III. STANDARD MINIMUM WEIGHTS.

Weights. 10. The standard minimum weights for tubes of various outside diameters and thicknesses, are as follows:

STANDARD MINIMUM WEIGHTS.

Thickness.		Weight, lb. per ft. of length. Outside Diameter, in.			
B. w. g.	In.	$1\frac{3}{4}$	2	$2\frac{1}{4}$	$2\frac{1}{2}$
13	0.095	1.65	1.91	2.16	....
12	0.110	1.89	2.17	2.46	2.73
11	0.125	2.07	2.38	2.70	3.02
10	0.135	2.29	2.64	2.99	3.37

[1] A solution of two parts water, one part concentrated hydrochloric acid, and one part concentrated sulphuric acid is recommended for the etch test.

IV. WORKMANSHIP AND FINISH.

Workmanship. 11. (*a*) The finished tubes shall be circular within 0.02 in., and the mean diameter shall not vary more than 0.015 in. from the size ordered. They shall not be shorter than the length ordered, but may exceed it by 0.125 in.

(*b*) The thickness at any point shall not vary more than 0.01 in. from that specified, except at the weld, where an additional thickness of 0.015 in. shall be allowed.

Finish. 12. The finished tubes shall have a smooth surface, free from laminations, cracks, blisters, pits, and imperfect welds, and shall have a workmanlike finish. They shall be free from kinks, bends and buckles, and evidences of unequal contraction in cooling or injury in manipulation.

V. MARKING.

Marking. 13. "Knobbled charcoal, tested to 500 lb. pressure," shall be legibly marked at the middle of the length of each tube.

VI. INSPECTION AND REJECTION.

Inspection. 14. The inspector representing the purchaser shall have free entry, at all times while work on the contract of the purchaser is being performed, to all parts of the manufacturer's works which concern the manufacture of the material ordered. The manufacturer shall afford the inspector, free of cost, all reasonable facilities to satisfy him that the material is being furnished in accordance with these specifications. All tests and inspection shall be made at the place of manufacture prior to shipment.

Rejection. 15. Tubes when inserted in the boiler shall stand expanding and beading without splitting or breaking. Tubes which fail in this manner will be rejected, and the manufacturer shall be notified.

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PHILADELPHIA, PA., U. S. A.

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STANDARD SPECIFICATIONS FOR HARD-DRAWN COPPER WIRE.

ADOPTED AUGUST 21, 1911.

Material. 1. The material shall be copper of such quality and purity that, when drawn hard, it shall have the properties and characteristics herein required.

Shapes. 2. These specifications cover hard-drawn round wire, grooved trolley wire, figure-eight trolley wire, and hard-drawn cable or strand, as hereinafter described.

Finish. 3. (*a*) The wire, in all shapes, must be free from all surface imperfections not consistent with the best commercial practice.

(*b*) Necessary brazes in hard-drawn wire must be made in accordance with best commercial practice, and tests upon a section of wire containing a braze must show at least 95 per cent. of the tensile strength of the unbrazed wire. Elongation tests are not to be made upon test sections including brazes.

Packages. 4. (*a*) Package sizes for round wire and for cable shall be agreed upon in the placing of individual orders; standard packages of grooved trolley wire shall be shipments upon reels holding about 2,500 lbs. each.

(*b*) The wire shall be protected against damage in ordinary handling and shipping.

Specific Gravity. 5. For the purpose of calculating weights, cross sections, etc., the specific gravity of copper shall be taken as 8.90.

Inspection.

6. All testing and inspection shall be made at the place of manufacture. The manufacturer shall afford the inspector representing the purchaser all reasonable facilities to enable him to satisfy himself that the material conforms to the requirements of these specifications.

HARD-DRAWN ROUND WIRE.

Dimensions and Permissible Variations.

7. (*a*) Size shall be expressed as the diameter of the wire in decimal fractions of an inch, using not more than three places of decimals; i. e., in mils.

(*b*) Wire is expected to be accurate in diameter; permissible variations from nominal diameter shall be:

For wire 0.100 in. in diameter and larger, one per cent. over or under;

For wire less than 0.100 in. in diameter, one mil over or under.

(*c*) Each coil is to be gauged at three places, one near each end, and one approximately at the middle; the coil may be rejected if, two points being within the accepted limits, the third point is off gauge more than 2 per cent. in the case of wire 0.064 in. in diameter and larger, or more than 3 per cent. in the case of wire less than 0.064 in. in diameter.

8. Wire shall be so drawn that its tensile strength and elongation shall be at least equal to the value stated in Table I. Tensile tests shall be made upon fair samples, and the elongation of wire larger in diameter than 0.204 in. shall be determined as the permanent increase in length, due to the breaking of the wire in tension, measured between bench marks placed upon the wire originally 10 ins. apart. The elongation of wire 0.204 in. in diameter and smaller shall be determined by measurements made between the jaws of the testing machine. The zero length shall be the distance between the jaws when a load equal to ten per cent. of the required ultimate breaking strength shall have been applied, and the final length shall be the distance between the jaws at the time of rupture. The zero length shall be as near 60 ins. as possible. The fracture shall be between the bench marks in the case of wire larger than 0.204 in. in diameter and between the jaws in the case of smaller wire, and not closer than 1 in. to either bench mark or jaw. If upon testing a sample from any coil of wire, the results are found to

be below the values stated in the table, tests upon two additional samples shall be made, and the average of the three tests shall determine acceptance or rejection of the coil. For wire whose nominal diameter is between listed sizes, the requirements shall be those of the next larger size included in the table.

TABLE I.

Diameter, ins.	Area, circular mils.	Tensile Strength, lbs. per sq. in.	Elongation in 10 ins., per cent.
0.460	211,600	49,000	3.75
0.410	168,100	51,000	3.25
0.365	133,225	52,800	2.80
0.325	105,625	54,500	2.40
0.289	83,520	56,100	2.17
0.258	66,565	57,600	1.98
0.229	52,440	59,000	1.79
			in 60 ins.
0.204	41,615	60,100	1.24
0.182	33,125	61,200	1.18
0.165	27,225	62,000	1.14
0.162	26,245	62,160	1.14
0.144	20,735	63,000	1.09
0.134	17,956	63,400	1.07
0.128	16,385	63,700	1.06
0.114	12,995	64,300	1.02
0.104	10,815	64,800	1.00
0.102	10,404	64,900	1.00
0.092	8,464	65,400	0.97
0.091	8,281	65,400	0.97
0.081	6,561	65,700	0.95
0.080	6,400	65,700	0.94
0.072	5,184	65,900	0.92
0.065	4,225	66,200	0.91
0.064	4,096	66,200	0.90
0.057	3,249	66,400	0.89
0.051	2,601	66,600	0.87
0.045	2,025	66,800	0.86
0.040	1,600	67,000	0.85

9. Electric conductivity shall be determined upon fair samples by resistance measurements at a temperature of 20° C. (68° F.). **Electric Conductivity**

The wire shall not exceed the following limits:

For diameters 0.460 in. to 0.325 in., 900.77 lbs. per mile-ohm at 20° C.

For diameters 0.324 in. to 0.040 in., 910.15 lbs. per mile-ohm at 20° C.

GROOVED TROLLEY WIRE.

10. Standard sections shall be those known as the "American Standard" grooved trolley wire sections, the shape and dimensions of which are as shown in Fig. 1.

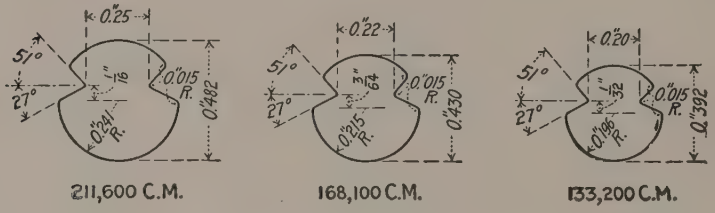

FIG. 1.

Dimensions and Permissible Variations.

11. (*a*) Size shall be expressed as the area of cross section in circular mils, the standard sizes being as follows:

211,600	circular	mils,	weighing	3,386	lbs.	per	mile.
168,100	"	"	"	2,690	"	"	"
133,200	"	"	"	2,132	"	"	"

(*b*) Grooved trolley wire may vary 4 per cent. over or under in weight per unit length from standard, as determined from the nominal cross section.

Physical Tests.

12. The physical tests shall be made in the same manner as those upon round wire. The tensile strength of grooved wire shall be at least 95 per cent. of that required for round wire of the same sectional area; the elongation shall be the same as that required for round wire of the same sectional area.

Electric Conductivity.

13. The requirements for electric conductivity shall be the same as those for round wire of the same sectional area.

FIGURE-EIGHT TROLLEY WIRE.

14. Standard sections of figure-eight trolley wire shall be as shown in Fig. 2. **Sections.**

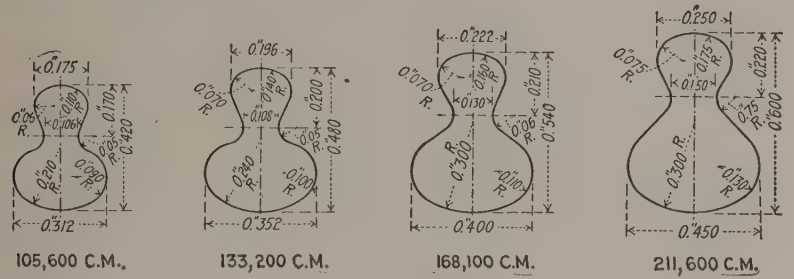

FIG. 2.

15. The requirements for weight, physical properties, and electric conductivity of figure-eight trolley wire shall be the same as for the same sizes of grooved trolley wire. **Requirements.**

HARD-DRAWN COPPER WIRE CABLE OR STRAND.

16. For the purposes of these specifications, standard cable shall be that made up of hard-drawn wire laid concentrically about a hard-drawn wire center. Cable laid up about a hemp center or about a soft wire core is to be subject to special specifications to be agreed upon in individual cases. **Construction.**

17. The wire entering into the construction of stranded cable shall, before stranding, meet all the requirements of round wire, hereinbefore stated. **Wire.**

18. The tensile strength of standard cable shall be at least 90 per cent. of the total strength required of the wires forming the cable. **Physical Tests.**

19. Brazes, made in accordance with the best commercial practice, will be permitted in wire entering into cable; but no two brazes in wire in the cable may be closer together than 50 ft. **Brazes.**

20. The pitch of standard cable shall not be less than 12, nor more than 16, diameters of the cable. The cable shall be laid left-handed or right-handed, as shall be agreed upon in the placing of individual orders. **Lay.**

EXPLANATORY NOTES ON STANDARD SPECIFICATIONS FOR HARD-DRAWN COPPER WIRE.

5. The specific gravity of copper has been commonly accepted as 8.9, and this value is retained in these specifications. The maximum variation from this figure in a large number of samples of wire has not been sufficient to lead one to anticipate any serious error from its use as a flat value in calculations.

7. (*a*) The use of arbitrary gauge numbers to express dimensions cannot be too strongly condemned. There are many such gauges in existence, and confusion is to be expected unless the particular gauge to be used is specified. Many of the gauges have their dimensions stated in absurd figures, such as 0.090742 in., when it is not especially easy to measure dimensions in the fourth decimal place by workshop tools. Definite diameters in measurable units are evidently preferable.

8. Many other physical tests than those provided in these specifications are included in existing specifications. The reasons for the omission of some of the more common are given as follows:

Twist Tests.—The wire is sometimes required to permit twisting through a stated number of revolutions before breaking. The results are so easily influenced by temperature, speed of rotation, method of gripping, and other variables not easily defined or controlled, that the test is at least of doubtful value. It is the opinion of the Committee that it is impractical to so define the conditions of the test that a twist test can be made definite and reliable; hence there is no warrant for its inclusion in specifications.

Wrap Tests.—Wire is sometimes required to permit tight wrapping about a wire of its own diameter, unwrapping and again re-wrapping. It is obvious that the making of a test of this kind with wire that is already hard-drawn is exceedingly difficult. Every one who has tried to break off a piece of tough wire by bending it back and forth between the fingers knows how hard it is to confine the bend to one place, because of the hardening action of the previous bends. Hard wire which has been wrapped around a wire of small diameter is hardened still more and it is almost impossible to straighten the wire, let alone re-coil it in the opposite direction. In the opinion of the Committee, it is inadvisable to include a test

which at best is so indefinite as a wrap test. Furthermore, it is the opinion of the Committee that wire which will meet the physical tests included in these specifications will meet any properly made twist or wrap test that would reasonably be required.

Since the adoption of the Standard Specifications for Hard-Drawn Copper Wire, proposed in 1909, the Committee has very carefully considered the matter of twist and wrap tests and it is their final opinion that while there might be some possible reason for requiring that wire shall stand wrapping around a wire of equal diameter, there can be no good reason for including in specifications the requirement that it shall stand unwrapping and re-wrapping, because such a test is indefinite and cannot be made otherwise. It is almost physically impossible to unwrap and re-wrap hard-drawn wire about a wire of its own diameter. With respect to twist tests, the Committee has nothing to add to the statement already on record, condemning this character of test.

Elastic Limit.—During the tension test on wire, there is seldom to be observed any definite drop of the beam or increase in the rate of elongation, corresponding to the yield point commonly observed in testing steel. The only way in which the elastic limit of hard wire may be determined is by the actual plotting of the elastic curve from extensometer readings. Even such tests are difficult of interpretation, because the wire when available for tests is usually curved, due to its having been put up in a coil. There are little sets observable before the true elastic limit has been reached, owing to the fact that one side of the wire, having been stretched in coiling, is really a little harder than the other side, and the pull is, therefore, not even. Considering the difficulty of making the test and the uncertainty of the results obtained, it is the opinion of the Committee that it would be inadvisable to include an elastic limit test in these specifications. It is evident that if the designing engineer requires a knowledge of the location of the elastic limit for purposes of calculation in designing, such data can be obtained by special tests on representative sizes of wire, which will fix the relation of the elastic limit to the ultimate strength for all wire which is properly made.

Tests carefully made by members of the Committee show that the elastic limit of hard-drawn copper wire from sizes 0.460 to 0.325 in., inclusive, averages 55 per cent. of the ultimate tensile

strength required in these specifications, with a minimum value of 50 per cent.; for sizes 0.324 to 0.040 in., inclusive, it averages 60 per cent. of the ultimate tensile strength required in these specifications with a minimum value of 55 per cent. This statement of experience is based on the definition of elastic limit as "that point on the elastic curve beyond which the ratio of stress to strain ceases to be constant."

9. *Conductivity.*—Electric conductivity is usually expressed as a percentage on the Matthiesen basis, reference being made to determinations of the electrical resistivity of supposedly pure copper by Matthiesen, about 1865. Since that time, the methods of refining copper have greatly improved, so that to-day it is not uncommon to find copper of over 100 per cent. conductivity on the Matthiesen basis. Furthermore, what the electrical engineer requires is that the wire shall not exceed a certain maximum electrical resistance. It seems obvious that it is less laborious to express quantities in direct definite terms, rather than by reference to something else which requires interpretation before the results are ready for use in calculation. Resistivity is commonly expressed in a number of different ways, all being equivalent to the resistance of some unit of cross section, this unit being expressed either in linear dimensions or as a combination of weight and dimensions.

For the convenience of those who are accustomed to expressing resistivity or conductivity in any one of several more or less common units, Table II has been prepared giving the conductivity and resistivity of copper at 20° C., expressed in the several common units and covering a range of resistivity that would be covered by copper meeting the terms of the specifications.

10. It is obvious that the simplest designation of irregular shapes of similar outline is by sectional area, and the most commonly used unit among electrical engineers is the circular mil. Therefore, while the sizes of grooved trolley wire regularly used are generally known by B & S gauge number, corresponding to their sectional area, it has been deemed advisable by the Committee to list these sizes, in specifications, by their sectional area expressed in circular mils. The three sizes which are most extensively used commercially are the only ones listed; a fourth size is but little used, and the use is growing less.

11. The only way in which gauge variations are easily

TABLE II.—CONDUCTIVITY AND RESISTIVITY OF COPPER.

Temperature 20° C. Density taken as 8.90.

Conductivity, per cent.	Ohms per meter-gram.	Lbs. per mile-ohm.	Microhms per cc.	Microhms per cu. in.	Ohms per mil-foot.
102.0	0.15002	856.62	1.6856	0.66363	10.140
101.9	0.15017	857.46	1.6873	0.66428	10.149
101.8	0.15032	858.30	1.6889	0.66494	10.159
101.7	0.15046	859.14	1.6906	0.66559	10.169
101.6	0.15061	859.99	1.6923	0.66625	10.179
101.5	0.15076	860.84	1.6939	0.66690	10.189
101.4	0.15091	861.68	1.6956	0.66756	10.200
101.3	0.15106	862.54	1.6973	0.66822	10.210
101.2	0.15121	863.39	1.6990	0.66888	10.220
101.1	0.15136	864.24	1.7006	0.66954	10.230
101.0	0.15151	865.10	1.7023	0.67020	10.240
100.9	0.15166	865.95	1.7040	0.67087	10.250
100.8	0.15181	866.81	1.7057	0.67153	10.260
100.7	0.15196	867.67	1.7074	0.67220	10.270
100.6	0.15211	868.54	1.7091	0.67287	10.281
100.5	0.15226	869.40	1.7108	0.67354	10.291
100.4	0.15241	870.27	1.7125	0.67421	10.301
100.3	0.15256	871.13	1.7142	0.67488	10.311
100.2	0.15272	872.00	1.7159	0.67555	10.322
100.1	0.15287	872.88	1.7176	0.67623	10.332
100.0	0.15302	873.75	1.7193	0.67691	10.342
99.9	0.15317	874.62	1.7211	0.67758	10.353
99.8	0.15333	875.50	1.7228	0.67826	10.363
99.7	0.15348	876.38	1.7245	0.67894	10.373
99.6	0.15364	877.26	1.7262	0.67962	10.384
99.5	0.15379	878.14	1.7280	0.68031	10.394
99.4	0.15394	879.02	1.7297	0.68099	10.405
99.3	0.15410	879.91	1.7315	0.68168	10.415
99.2	0.15426	880.79	1.7332	0.68236	10.426
99.1	0.15441	881.68	1.7350	0.68305	10.436
99.0	0.15457	882.57	1.7367	0.68374	10.447
98.9	0.15472	883.47	1.7385	0.68443	10.457
98.8	0.15488	884.36	1.7402	0.68513	10.468
98.7	0.15504	885.26	1.7420	0.68582	10.479
98.6	0.15519	886.15	1.7438	0.68652	10.489
98.5	0.15535	887.05	1.7455	0.68721	10.500
98.4	0.15551	887.96	1.7473	0.68791	10.510
98.3	0.15567	888.86	1.7491	0.68861	10.521
98.2	0.15583	889.76	1.7509	0.68931	10.532
98.1	0.15598	890.67	1.7526	0.69002	10.543
98.0	0.15614	891.58	1.7544	0.69072	10.553
97.9	0.15630	892.49	1.7562	0.69142	10.564
97.8	0.15646	893.40	1.7580	0.69213	10.575
97.7	0.15662	894.32	1.7598	0.69284	10.586
97.6	0.15678	895.23	1.7616	0.69355	10.597
97.5	0.15694	896.15	1.7634	0.69426	10.607
97.4	0.15711	897.07	1.7652	0.69497	10.618
97.3	0.15727	897.99	1.7671	0.69569	10.629
97.2	0.15743	898.92	1.7689	0.69640	10.640
97.1	0.15759	899.84	1.7707	0.69712	10.651
97.0	0.15775	900.77	1.7725	0.69784	10.662
96.9	0.15792	901.70	1.7743	0.69856	10.673
96.8	0.15808	902.63	1.7762	0.69928	10.684
96.7	0.15824	903.57	1.7780	0.70001	10.695
96.6	0.15841	904.50	1.7799	0.70073	10.706
96.5	0.15857	905.44	1.7817	0.70146	10.717
96.4	0.15874	906.38	1.7835	0.70218	10.729
96.3	0.15890	907.32	1.7854	0.70291	10.740
96.2	0.15907	908.26	1.7873	0.70364	10.751
96.1	0.15923	909.21	1.7891	0.70438	10.762
96.0	0.15940	910.15	1.7910	0.70511	10.773

determinable in irregular shapes is by recourse to weights of standard lengths, and this has been the method adopted in the specifications.

16. So many variations in the construction of cable are possible that it has been deemed inadvisable to complicate the specifications by including requirements for any other than the one type most commonly used.

18. Physical testing of cable is at best a difficult matter, and the measurement of elongation in cable which has been subjected to a tensile test is uncertain, since it includes the elastic deformation of the cable as a spring, the actual elongation of the wires, and perhaps even some elastic deformation of the wires as such. It is, therefore, thought inadvisable to include a requirement covering an elongation test.

19. The permitting of brazes in wire entering into the construction of copper cable was discussed at considerable length, and it is finally the opinion of the Committee that, provided no two brazes are closer together than 50 ft., the cable has fully 90 per cent. of the theoretical strength obtained by adding together the required strengths of the constituent wires. This is due, in such long lengths, to the frictional gripping of the wires in the cable. The construction of long lengths of cable without brazes is costly, and it has been thought best, therefore, to permit their use, provided they are sufficiently widely spaced as not to be detrimental to the strength of the cable.

[NOTE.—It is to be expected that at the meeting of the International Electrotechnical Commission in 1913, an international agreement will be reached upon a copper conductivity standard, which may be slightly different from the values stated in Table II.—ED.]

AMERICAN SOCIETY FOR TESTING MATERIALS

PHILADELPHIA, PA., U. S. A.

AFFILIATED WITH THE

INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.

STANDARD SPECIFICATIONS

FOR

MEDIUM HARD-DRAWN COPPER WIRE.

ADOPTED JUNE 1, 1912.

1. The copper shall be of such quality and purity that, when drawn medium-hard, it shall have the properties and characteristics herein required.

2. These specifications cover medium hard-drawn round wire and cable or strand made from medium hard-drawn wire, as hereinafter described.

3. (*a*) The wire must be free from all surface imperfections not consistent with the best commercial practice.

(*b*) Necessary brazes in medium hard-drawn wire must be made in accordance with the best commercial practice, and tests upon a section of wire containing a braze must show at least 95 per cent of the tensile strength of the unbrazed wire. Elongation tests are not to be made upon test sections including brazes.

4. (*a*) Package sizes for round wire and for cable shall be agreed upon in the placing of individual orders.

(*b*) The wire shall be protected against damage in ordinary handling and shipping.

5. For the purpose of calculating weights, cross-sections, etc., the specific gravity of copper shall be taken as 8.90.

6. All testing and inspection shall be made at the place of manufacture. The manufacturer shall afford the inspector rep-

resenting the purchaser all reasonable facilities to satisfy him that the material conforms to the requirements of these specifications.

MEDIUM HARD-DRAWN ROUND WIRE.

7. (*a*) The size shall be expressed as the diameter of the wire in decimal fractions of an inch, using not more than three places of decimals; that is in mils.

(*b*) Wire is expected to be accurate in diameter; permissible variations from nominal diameter shall be:

For wire 0.100 in. in diameter and larger, 1 per cent over or under.

For wire less than 0.100 in. in diameter, one mil over or under.

(*c*) Each coil is to be gaged at three places, one near each end, and one approximately at the middle; the coil may be rejected, if, two points being within the accepted limits, the third point is off gage more than 2 per cent in the case of wire 0.064 in. in diameter and larger, or more than 3 per cent in the case of wire less than 0.064 in. in diameter.

8. Wire shall be so drawn that its tensile strength shall not be greater than the maximum values and not less than the minimum values stated in Table I, and its elongation shall not be less than the minimum values stated in Table I. Tension tests shall be made upon fair samples, and the elongation of wire larger in diameter than 0.204 in. shall be determined as the permanent increase in length, due to the breaking of the wire in tension, measured between bench marks placed upon the wire originally 10 in. apart. The elongation of wire 0.204 in. in diameter and smaller shall be determined by measurements made between the jaws of the testing machine. The zero length shall be the distance between the jaws when a load equal to 10 per cent of the required ultimate breaking strength shall have been applied, and the final length shall be the distance between the jaws at the time of rupture. The zero length shall be as near 60 in. as possible. The fracture shall be between the bench marks in the case of wire larger than 0.204 in. in diameter and between the jaws in the case of smaller wire, and not closer than 1 in. to

either bench mark or jaw. If upon testing a sample from any coil of wire, the results are found to be below the values stated in the table, tests upon two additional samples shall be made, and the average of the three tests shall determine acceptance or rejection of the coil. For wire whose nominal diameter is between listed sizes, the requirements shall be those of the next larger size included in the table.

TABLE I.

Diameter, in.	Tensile Strength, lb. per sq. in.		Elongation in 10 in. per cent.
	Minimum.	Maximum.	
0.460	42 000	49 000	3.75
0.410	43 000	50 000	3.6
0.365	44 000	51 000	3.25
0.325	45 000	52 000	3.0
0.289	46 000	53 000	2.75
0.258	47 000	54 000	2.5
0.229	48 000	55 000	2.25
			in 60 in.
0.204	48 330	55 330	1.25
0.182	48 600	55 660	1.20
0.162	49 000	56 000	1.15
0.144	49 330	56 330	1.11
0.128	49 660	56 660	1.08
0.114	50 000	57 000	1.06
0.102	50 330	57 330	1.04
0.091	50 660	57 660	1.02
0.081	51 000	58 000	1.00
0.072	51 330	58 330	0.98
0.064	51 660	58 660	0.96
0.057	52 000	59 000	0.94
0.051	52 330	59 330	0.92
0.045	52 660	59 660	0.90
0.040	53 000	60 000	0.88

9. Electric conductivity shall be determined upon fair samples by resistance measurements at a temperature of 20° C. (68° F.).

The wire shall not exceed the following limits:

For diameters 0.460 in. to 0.325 in. 896.15 lb. per mile-ohm at 20° C.

For diameters 0.324 in. to 0.040 in. 905.44 lb. per mile-ohm at 20° C.

MEDIUM HARD-DRAWN COPPER-WIRE CABLE OR STRAND.

10. For the purposes of these specifications, standard cable shall be that made up of medium hard-drawn wire laid concentrically about a medium hard-drawn wire center. Cable laid up about a hemp center or about a soft wire core is to be subject to special specifications to be agreed upon in individual cases.

11. The wire entering into the construction of standard cable shall, before stranding, meet all the requirements of round wire, hereinbefore stated, except that brazes may be made in the wire when finished and ready for stranding. Such brazes must be made in accordance with the best commercial practice, and no two brazes in wire in the cable may be closer together than 50 ft.

12. The tensile strength of standard cable shall be at least 90 per cent of the total strength required of the wires forming the cable.

13. The pitch of standard cable shall not be less than 12 nor more than 16 diameters of the cable. The cable shall be laid left-handed or right-handed, as shall be agreed upon in the placing of individual orders.

EXPLANATORY NOTES.

Definition.—Medium Hard-Drawn Wire is essentially and necessarily a special product, because when wire has once started on its course through the drawing operations, it can only finish as a hard-drawn wire to be used as such or to be annealed and become soft or annealed wire. Medium hard-drawn wire is annealed wire drawn to a slightly smaller diameter.

5. The specific gravity of copper has been commonly accepted as 8.90 and this value is retained in these specifications. The maximum variation from this figure in a large number of samples of wire has not been sufficient to lead one to anticipate any serious error from its use as a flat value in calculations.

7. (*a*) The use of arbitrary gage numbers to express dimensions cannot be too strongly condemned. There are many such gages in existence, and confusion is to be expected unless the particular gage to be used is specified. Many of the gages have their dimensions stated in absurd figures, such as 0.090742 in., when it is not especially easy to measure dimensions in the fourth

decimal place by workshop tools. Definite diameters in measureable units are evidently preferable.

8. Medium hard-drawn wire approaches hard-drawn wire in its characteristics, but from the very nature of the product, exact uniformity in tensile strength cannot be obtained; hence, the necessity for establishing a range of tensile strength within which standard medium hard-drawn wire must be expected to be found. In the opinion of the Committee any narrowing or reduction in the range permitted in tensile strength can only result in an unjustifiable increase in the cost of production of the wire.

Many other physical tests than those provided in these specifications are included in existing specifications. The reasons for the omission of some of the more common are given as follows:

Twist Tests.—The wire is sometimes required to permit twisting through a stated number of revolutions before breaking. The results are so easily influenced by temperature, speed of rotation, method of gripping, and other variables not easily defined or controlled, that the test is at least of doubtful value. It is the opinion of the Committee that it is impractical to so define the conditions of the test that a twist test can be made definite and reliable; hence there is no warrant for its inclusion in specifications.

Wrap Tests.—Wire is sometimes required to permit tight wrapping about a wire of its own diameter, unwrapping and again re-wrapping. It is obvious that the making of a test of this kind with wire that is already hard is exceedingly difficult. Every one who has tried to break off a piece of tough wire by bending it back and forth, between the fingers, knows how hard it is to confine the bend to one place, because of the hardening action of the previous bends. Hard wire which has been wrapped around a wire of small diameter is hardened still more and it is almost impossible to straighten the wire, let alone re-coil it in the opposite direction. In the opinion of the Committee, it is inadvisable to include a test which at best is so indefinite as a wrap test. Furthermore, it is the opinion of the Committee that wire which will meet the physical tests included in these specifications

will meet any properly made twist or wrap test that would reasonably be required.

The Committee has carefully considered the matter of twist and wrap tests in connection with both hard-drawn and medium hard-drawn wire, and it is their final opinion that while there might be some possible reason for requiring that wire shall stand wrapping around a wire of equal diameter, there can be no good reason for including in specifications the requirement that it shall stand unwrapping and re-wrapping, because such a test is indefinite and cannot be made otherwise. It is almost physically impossible to unwrap and re-wrap hard-drawn wire about a wire of its own diameter.

Elastic Limit.—During the tension test on wire, there is seldom to be observed any definite drop of the beam or increase in the rate of elongation, corresponding to the yield point commonly observed in testing steel. The only way in which the elastic limit of hard wire may be determined is by the actual plotting of the elastic curve from extensometer readings. Even such tests are difficult of interpretation, because the wire when available for tests is usually curved, due to its having been put up in a coil. There are little sets observable before the true elastic limit has been reached, owing to the fact that one side of the wire, having been stretched in coiling, is really a little harder than the other side, and the pull is, therefore, not even. Considering the difficulty of making the test and the uncertainty of the results obtained, it is the opinion of the Committee that it would be inadvisable to include an elastic limit test in these specifications. It is evident that if the designing engineer requires a knowledge of the location of the elastic limit, for purposes of calculation in designing, such data can be obtained by special tests on representative sizes of wire, which will fix the relation of the elastic limit to the ultimate strength for all wire which is properly made.

Tests carefully made by members of the Committee show that the elastic limit of medium hard-drawn wire averages 50 per cent of the ultimate tensile strength required in these specifications. This statement of experience is based on the definition of elastic limit as "that point on the elastic curve beyond which the ratio of stress to strain ceases to be constant."

9. *Conductivity.*—Electric conductivity is usually expressed as a percentage on the Matthiesen basis, reference being made to determinations of the electrical resistivity of supposedly pure copper by Matthiesen, about 1865. Since that time, the methods of refining copper have greatly improved, so that to-day it is not uncommon to find copper of over 100 per cent conductivity on the Matthiesen basis. Furthermore, what the electrical engineer requires is that the wire shall not exceed a certain maximum electrical resistance. It seems obvious that it is less laborious to express quantities in direct definite terms, rather than by reference to something else which requires interpretation before the results are ready for use in calculation. Resistivity is commonly expressed in a number of different ways, all being equivalent to the resistance of some unit of cross section, this unit being expressed either in linear dimensions or as a combination of weight and dimensions.

For the convenience of those who are accustomed to expressing resistivity or conductivity in any one of several more or less common units, Table II has been prepared giving the conductivity and resistivity of copper at 20° C., expressed in the several common units and covering a range of resistivity that would be covered by copper meeting the terms of the specifications.

10. So many variations in the construction of cable are possible that it has been deemed inadvisable to complicate the specifications by including requirements for any other than the one type most commonly used.

11. The permitting of brazes in wire entering into the construction of copper cable was discussed at considerable length, and it is finally the opinion of the Committee that, provided no two brazes are closer together than 50 ft., the cable has fully 90 per cent of the theoretical strength obtained by adding together the required strengths of the constituent wires, even when the braze has been made after the wire has been drawn medium hard. This is due, in such long lengths, to the frictional gripping of the wires in the cable. The construction of long lengths of cable without brazes is costly, and it has been thought best, therefore, to permit their use, provided they are sufficiently widely spaced as not to be detrimental to the strength of the cable.

TABLE II.—CONDUCTIVITY AND RESISTIVITY OF COPPER.

Temperature 20° C. Specific Gravity taken as 8.90.

Conductivity, per cent.	Ohms per meter-gram.	Lb. per mile-ohm.	Microhms per cc.	Microhms per cu. in.	Ohms per mil-foot.
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101.9	0.15017	857.46	1.6873	0.66428	10.149
101.8	0.15032	858.30	1.6889	0.66494	10.159
101.7	0.15046	859.14	1.6906	0.66559	10.169
101.6	0.15061	859.99	1.6923	0.66625	10.179
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100.8	0.15181	866.81	1.7057	0.67153	10.260
100.7	0.15196	867.67	1.7074	0.67220	10.270
100.6	0.15211	868.54	1.7091	0.67287	10.281
100.5	0.15226	869.40	1.7108	0.67354	10.291
100.4	0.15241	870.27	1.7125	0.67421	10.301
100.3	0.15256	871.13	1.7142	0.67488	10.311
100.2	0.15272	872.00	1.7159	0.67555	10.322
100.1	0.15287	872.88	1.7176	0.67623	10.332
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99.9	0.15317	874.62	1.7211	0.67758	10.353
99.8	0.15333	875.50	1.7228	0.67826	10.363
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99.5	0.15379	878.14	1.7280	0.68031	10.394
99.4	0.15394	879.02	1.7297	0.68099	10.405
99.3	0.15410	879.91	1.7315	0.68168	10.415
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98.6	0.15519	886.15	1.7438	0.68652	10.489
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98.3	0.15567	888.86	1.7491	0.68861	10.521
98.2	0.15583	889.76	1.7509	0.68931	10.532
98.1	0.15598	890.67	1.7526	0.69002	10.543
98.0	0.15614	891.58	1.7544	0.69072	10.553
97.9	0.15630	892.49	1.7562	0.69142	10.564
97.8	0.15646	893.40	1.7580	0.69213	10.575
97.7	0.15662	894.32	1.7598	0.69284	10.586
97.6	0.15678	895.23	1.7616	0.69355	10.597
97.5	0.15694	896.15	1.7634	0.69426	10.607
97.4	0.15711	897.07	1.7652	0.69497	10.618
97.3	0.15727	897.99	1.7671	0.69569	10.629
97.2	0.15743	898.92	1.7689	0.69640	10.640
97.1	0.15759	899.84	1.7707	0.69712	10.651
97.0	0.15775	900.77	1.7725	0.69784	10.662
96.9	0.15792	901.70	1.7743	0.69856	10.673
96.8	0.15808	902.63	1.7762	0.69928	10.684
96.7	0.15824	903.57	1.7780	0.70001	10.695
96.6	0.15841	904.50	1.7799	0.70073	10.706
96.5	0.15857	905.44	1.7817	0.70146	10.717
96.4	0.15874	906.38	1.7835	0.70218	10.729
96.3	0.15890	907.32	1.7854	0.70291	10.740
96.2	0.15907	908.26	1.7873	0.70364	10.751
96.1	0.15923	909.21	1.7891	0.70438	10.762
96.0	0.15940	910.15	1.7910	0.70511	10.773

12. Physical testing of cable is at best a difficult matter, and the measurement of elongation in cable which has been subjected to a tension test is uncertain, since it includes the elastic deformation of the cable as a spring, the actual elongation of the wires, and perhaps even some elastic deformation of the wires as such. It is, therefore, thought inadvisable to include a requirement covering an elongation test.

[NOTE.—It is to be expected that at the meeting of the International Electrotechnical Commission in 1913, an international agreement will be reached upon a copper conductivity standard, which may be slightly different from the values stated in Table II.—ED.]

AMERICAN SOCIETY FOR TESTING MATERIALS

PHILADELPHIA, PA., U. S. A.

AFFILIATED WITH THE

INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.

STANDARD SPECIFICATIONS.

FOR

SOFT OR ANNEALED COPPER WIRE.

ADOPTED JUNE 1, 1912.

1. The copper shall be of such quality and purity that, when drawn and annealed, it shall have the properties and characteristics herein required.

2. These specifications cover untinned drawn and annealed round wire.

3. (*a*) The wire must be free from all surface imperfections not consistent with the best commercial practice.

(*b*) Necessary brazes in soft or annealed wire must be made in accordance with the best commercial practice.

4. (*a*) Wire may be shipped in coils or on reels as agreed upon by the purchaser and manufacturer. In Table I there are stated the maximum and minimum weights of wire of the stated sizes which may be shipped in any one package, whether coil, reel or spool; in the case of wire larger than 0.010 in. in diameter, the maximum and minimum package weights are net, and in the case of wire 0.010 in. and less in diameter, the maximum package weights are gross, and the minimum package weights are net. The table also states the limiting of the dimensions of the coils, reels and spools on which wire may be shipped. The length and diameter stated for reels and spools are to be measured over all and are maximum sizes; reels or spools smaller than these may be used provided the minimum weights called for are carried by

the reel or spool. In the table, there are also stated the diameters of the draw-block on which the final drawing of the wire is to be made, when wire is shipped in coils; it being understood that the wire is not to be re-wound after final drawing. This provision is made to insure that coils of wire of a given gage, when supplied by different manufacturers, will be of the same general dimensions.

TABLE I.

Diameters, in.	Package Weights. Pounds.		Diam. of Draw-block, in.	Dimensions of Reels and Spools, in.		
	Max.	Min		Max. Dia.	Max. Length	Diameter of Hole for Rod.
0.460 to 0.360	520	290	24	32	21	$1\frac{1}{2}$ to $2\frac{1}{2}$
0.359 " 0.258	430	290	24	32	21	$1\frac{1}{2}$ " $2\frac{1}{2}$
0.257 " 0.129	290	140	22	4	12	$1\frac{1}{2}$ " $2\frac{1}{2}$
0.128 " 0.102	230	95	22	24	12	$\frac{5}{8}$ " $1\frac{1}{2}$
0.101 " 0.083	230	75	22	24	12	$\frac{5}{8}$ " $1\frac{1}{2}$
0.082 " 0.081	200	75	16	24	12	$\frac{5}{8}$ " $1\frac{1}{2}$
0.080 " 0.064	200	50	16	24	12	$\frac{5}{8}$ " $1\frac{1}{2}$
0.063 " 0.051	120	50	16	24	10	$\frac{5}{8}$ " $1\frac{1}{2}$
0.050 " 0.041	100	50	16	24	10	$\frac{5}{8}$ " $1\frac{1}{2}$
0.040 " 0.032	50	20	8	24	8	$\frac{5}{8}$ " $1\frac{1}{8}$
0.031 " 0.020	25	15	8	10	$6\frac{1}{2}$	$\frac{5}{8}$ " $\frac{7}{8}$
0.019 " 0.011	10	5	8	$5\frac{1}{2}$	4	$\frac{3}{8}$ " $1\frac{1}{16}$
0.010 " 0.008	5	$2\frac{1}{2}$	8	4	4	$\frac{3}{8}$ " $1\frac{1}{16}$
0.007 " 0.0056	$2\frac{1}{2}$	1	6	$2\frac{1}{2}$	4	$\frac{3}{8}$ " $1\frac{1}{16}$
0.005	$1\frac{1}{2}$	$\frac{5}{8}$	6	$2\frac{1}{2}$	4	$\frac{3}{8}$ " $1\frac{1}{16}$
0.004	$1\frac{1}{2}$	$\frac{3}{8}$	6	$2\frac{1}{2}$	4	$\frac{3}{8}$ " $1\frac{1}{16}$
0.003	1	$\frac{1}{4}$	6	$2\frac{1}{2}$	4	$\frac{3}{8}$ " $1\frac{1}{16}$

Wire 0.204 in. in diameter and larger may be shipped in larger packages when agreed upon.

(*b*) The wire shall be protected against damage in ordinary handling and shipping.

5. For the purpose of calculating weights, cross-sections, etc., the specific gravity of copper shall be taken as 8.90.

6. (*a*) Size shall be expressed as the diameter of the wire in decimal fractions of an inch.

(*b*) Wire shall be accurate in diameter; permissible variations from nominal diameter shall be:

For wire 0.010 in. in diameter and larger, 1 per cent over or under.

For wire less than 0.010 in. in diameter, 0.1 mil (0.0001 in.) over or under.

(*c*) Each coil shall be gaged at three places, one near each end and one approximately at the middle; from spools, approximately twelve feet shall be reeled off, the wire shall be gaged in six places between the second and twelfth foot from the end. The coils or spools will be rejected if the average of the measurements obtained is not within the limits in (*b*).

7. Wire shall be so drawn and annealed that its tensile strength shall not be greater than the value stated in Table II and its elongation not less than the value stated in Table II. Tensile tests shall be made upon fair samples, and the elongation shall be determined as the permanent increase in length, due to the breaking of the wire in tension, measured between bench marks placed upon the wire originally 10 in. apart. The fracture shall be between the bench marks and not closer than 1 in. to either bench mark. If upon testing a sample from any coil, reel or spool of wire, the results are found to be below the stated value in elongation or above the stated value in tensile strength, tests upon two additional samples shall be made, and the average of the three tests shall determine acceptance or rejection of the coil. For wire whose nominal diameter is between listed sizes, the requirements shall be those of the next larger size included in the table.

TABLE II.

Diameter, in.	Tensile Strength, lb. per sq. in.	Elongation in 10 in., per cent.
0.460 to 0.290	36 000	35
0.289 " 0.103	37 000	30
0.102 " 0.021	38 500	25
0.020 " 0.003	40 000	20

8. Electric conductivity shall be determined upon fair samples by resistance measurements at a temperature of 20° C. (68° F.), and it shall not exceed 891.58 lb. per mile-ohm.

9. All testing and inspection shall be made at the place of manufacture. The manufacturer shall afford the inspector representing the purchaser all reasonable facilities to satisfy him that the material conforms to the requirements of these specifications.

EXPLANATORY NOTES.

Soft or annealed copper wire is wire which has been drawn by customary operations and annealed, and finished by cleaning when necessary to remove scale or oxide. The wire is so soft and ductile that it is easily marred and even stretched by careless handling in the operations of winding or cabling, hence the necessity for confining specifications and inspection to wire in packages as it leaves the manufacturer, and before being put through processes incident to its use by the purchaser.

4. (*a*) Attention is called to the necessity for the purchaser and manufacturer agreeing on the package weights which will be standard under any individual contract. The Committee has indicated limitations to standard package weights which in their opinion will provide packages of sufficient size to be desirable, and without being so large that the wire is apt to be damaged in handling.

5. The specific gravity of copper has been commonly accepted as 8.90, and this value is retained in these specifications. The maximum variation from this figure in a large number of samples of wire has not been sufficient to lead one to anticipate any serious error from its use as a flat value in calculations.

6. The use of arbitrary gage numbers to express dimensions cannot be too strongly condemned. There are many such gages in existence, and confusion is to be expected unless the particular gage to be used is specified. Many of the gages have their dimensions stated in absurd figures, such as 0.090742 in., when it is not especially easy to measure dimensions in the fourth decimal place by workshop tools. Definite diameters in measureable units are evidently preferable.

8. *Conductivity.*—Electric conductivity is usually expressed as a percentage on the Matthiesen basis, reference being made to determinations of the electrical resistivity of supposedly pure copper by Matthiesen, about 1865. Since that time, the methods of refining copper have greatly improved, so that to-day it is not uncommon to find copper of over 100 per cent conductivity on the Matthiesen basis. Furthermore, what the electrical engineer requires is that the wire shall not exceed a certain maximum electrical resistance. It seems obvious that it is less laborious to express quantities in direct definite terms, rather than by

TABLE III.—CONDUCTIVITY AND RESISTIVITY OF COPPER.

Temperature 20° C. Specific Gravity taken as 8.90.

Conductivity, per cent.	Ohms per meter-gram.	Lb. per mile-ohm.	Microhms per cc.	Microhms per cu. in.	Ohms per mil-foot.
102.0	0.15002	856.62	1.6856	0.66363	10.140
101.9	0.15017	857.46	1.6873	0.66428	10.149
101.8	0.15032	858.30	1.6889	0.66494	10.159
101.7	0.15046	859.14	1.6906	0.66559	10.169
101.6	0.15061	859.99	1.6923	0.66625	10.179
101.5	0.15076	860.84	1.6939	0.66690	10.189
101.4	0.15091	861.68	1.6956	0.66756	10.200
101.3	0.15106	862.54	1.6973	0.66822	10.210
101.2	0.15121	863.39	1.6990	0.66888	10.220
101.1	0.15136	864.24	1.7006	0.66954	10.230
101.0	0.15151	865.10	1.7023	0.67020	10.240
100.9	0.15166	865.95	1.7040	0.67087	10.250
100.8	0.15181	866.81	1.7057	0.67153	10.260
100.7	0.15196	867.67	1.7074	0.67220	10.270
100.6	0.15211	868.54	1.7091	0.67287	10.281
100.5	0.15226	869.40	1.7108	0.67354	10.291
100.4	0.15241	870.27	1.7125	0.67421	10.301
100.3	0.15256	871.13	1.7142	0.67488	10.311
100.2	0.15272	872.00	1.7159	0.67555	10.322
100.1	0.15287	872.88	1.7176	0.67623	10.332
100.0	0.15302	873.75	1.7193	0.67691	10.342
99.9	0.15317	874.62	1.7211	0.67758	10.353
99.8	0.15333	875.50	1.7228	0.67826	10.363
99.7	0.15348	876.38	1.7245	0.67894	10.373
99.6	0.15364	877.26	1.7262	0.67962	10.384
99.5	0.15379	878.14	1.7280	0.68031	10.394
99.4	0.15394	879.02	1.7297	0.68099	10.405
99.3	0.15410	879.91	1.7315	0.68168	10.415
99.2	0.15426	880.79	1.7332	0.68236	10.426
99.1	0.15441	881.68	1.7350	0.68305	10.436
99.0	0.15457	882.57	1.7367	0.68374	10.447
98.9	0.15472	883.47	1.7385	0.68443	10.457
98.8	0.15488	884.36	1.7402	0.68513	10.468
98.7	0.15504	885.26	1.7420	0.68582	10.479
98.6	0.15519	886.15	1.7438	0.68652	10.489
98.5	0.15535	887.05	1.7455	0.68721	10.500
98.4	0.15551	887.96	1.7473	0.68791	10.510
98.3	0.15567	888.86	1.7491	0.68861	10.521
98.2	0.15583	889.76	1.7509	0.68931	10.532
98.1	0.15598	890.67	1.7526	0.69002	10.543
98.0	0.15614	891.58	1.7544	0.69072	10.553
97.9	0.15630	892.49	1.7562	0.69142	10.564
97.8	0.15646	893.40	1.7580	0.69213	10.575
97.7	0.15662	894.32	1.7598	0.69284	10.586
97.6	0.15678	895.23	1.7616	0.69355	10.597
97.5	0.15694	896.15	1.7634	0.69426	10.607
97.4	0.15711	897.07	1.7652	0.69497	10.618
97.3	0.15727	897.99	1.7671	0.69569	10.629
97.2	0.15743	898.92	1.7689	0.69640	10.640
97.1	0.15759	899.84	1.7707	0.69712	10.651
97.0	0.15775	900.77	1.7725	0.69784	10.662
96.9	0.15792	901.70	1.7743	0.69856	10.673
96.8	0.15808	902.63	1.7762	0.69928	10.684
96.7	0.15824	903.57	1.7780	0.70001	10.695
96.6	0.15841	904.50	1.7799	0.70073	10.706
96.5	0.15857	905.44	1.7817	0.70146	10.717
96.4	0.15874	906.38	1.7835	0.70218	10.729
96.3	0.15890	907.32	1.7854	0.70291	10.740
96.2	0.15907	908.26	1.7873	0.70364	10.751
96.1	0.15923	909.21	1.7891	0.70438	10.762
96.0	0.15940	910.15	1.7910	0.70511	10.773

reference to something else which requires interpretation before the results are ready for use in calculations. Resistivity is commonly expressed in a number of different ways, all being equivalent to the resistance of some unit of cross-section, this unit being expressed either in linear dimensions or as a combination of weight and dimensions.

For the convenience of those who are accustomed to expressing resistivity or conductivity in any one of several more or less common units, Table III has been prepared giving the conductivity and resistivity of copper at 20° C., expressed in the several common units and covering a range of resistivity that would be covered by copper meeting the terms of the specifications.

[NOTE.—It is to be expected that at the meeting of the International Electrotechnical Commission in 1913, an international agreement will be reached upon a copper conductivity standard, which may be slightly different from the values stated in Table III.—ED.]

AMERICAN SOCIETY FOR TESTING MATERIALS

PHILADELPHIA, PA., U. S. A.

AFFILIATED WITH THE

INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.

STANDARD SPECIFICATIONS FOR COPPER-WIRE BARS, CAKES, SLABS, BILLETS, INGOTS, AND INGOT BARS.

ADOPTED AUGUST 21, 1911.

Marks. 1. All wire bars, cakes, slabs, and billets shall be stamped with the maker's brand and furnace charge mark. Ingots and ingot bars shall have a brand stamped or cast in, but need have no furnace charge mark.

Lots. 2. The refiner shall arrange carloads or lots so that as far as possible each shall contain pieces from but one furnace charge, in order to facilitate testing by the user.

Quality. 3. (*a*) *Metal Contents.*—The copper in all shapes shall have a purity of at least 99.880 per cent as determined by electrolytic assay, silver being counted as copper.

(*b*) *Conductivity.*—All wire bars shall have a conductivity of at least 98.5 per cent (annealed); all ingots and ingot bars shall have a conductivity of at least 97.5 per cent (annealed), excepting only arsenical copper, which shall have a conductivity of not less than 90 per cent (annealed).

Cakes, slabs, and billets shall come under the ingot classification, except when specified for electrical use at time of purchase, in which case wire-bar classification shall apply.

The "Annealed Copper Standard," or resistance of a metergram of standard annealed copper at 20° C., shall be considered as 0.15302 international ohm. The per cent conductivity for the purposes of this specification shall be calculated by dividing the resistivity of the Annealed Copper Standard by the resistivity of the sample at 20° C.

Physical Standard.

4. Wire bars, cakes, slabs, and billets shall be substantially free from shrink holes, cold sets, pits, sloppy edges, concave tops and similar defects in set or casting. This clause shall not apply to ingots or ingot bars, in which case physical defects are of no consequence.

Weights of Individual Pieces.

5. Five per cent variation in weight or $\frac{1}{4}$ in. variation in any dimension from the refiner's published list or purchaser's specified size shall be considered good delivery; provided, however, that wire bars may vary in length 1 per cent from the listed or specified length, and cakes 3 per cent from the listed or specified size in any dimension greater than 8 in. The weight of ingot and ingot-bar copper shall not exceed that specified by more than 10 per cent, but otherwise its variation is not important.

Claims.

6. Claims must be made in writing within thirty days of receipt of copper at the customer's mill, and the results of the customer's tests shall accompany such claims. The refiner shall be given one week from date of receipt of complaint to investigate his records, and shall then either agree to replace the defective copper or send a representative to the mill. No claims will be considered unless made as above stated, and if the copper in question, unused, cannot be shown to the refiner's representative.

Claims against quality will be considered as follows:

(*a*) Conductivity by furnace charges, ingot lots, or ingot-bar lots.

(*b*) Metal contents by furnace charges, ingot lots, or ingot-bar lots.

(*c*) Physical defects by individual pieces.

(*d*) Variation in weights or dimensions by individual pieces.

Investigation of Claims.

7. The refiner's representative shall inspect all pieces where physical defects or weight or dimension variation is claimed. If agreement is not reached the question of fact shall be submitted to a mutually agreeable umpire, whose decision shall be final.

In a question of metal contents each party shall select a sample of two pieces. These shall be drilled in the presence of both parties, several holes approximately $\frac{1}{2}$ in. in diameter being drilled completely through each piece, scale from set to be rejected. No lubricant shall be used and drilling shall not be forced sufficiently to cause oxidation of chips. The resulting samples shall be cut up, mixed, and separated into three parts, each of which shall be

placed in a sealed package, one for each party and one for the umpire if necessary. Each party shall make an analysis, and if the results do not establish or dismiss the claim to the satisfaction of both parties the third sample shall be submitted to a mutually agreeable umpire, who shall determine the question of fact, and whose determination shall be final.

In a question of conductivity each party shall select two samples, and in the presence of both parties these shall be rolled hot and drawn cold into wire of 0.080 in. diameter, which shall be annealed at approximately 500° C. Three samples shall be cut from each coil and the same procedure followed as described in the previous paragraph.

Settlement of Claims.

8. The expenses of the shipper's representative and of the umpire shall be paid by the loser, or divided in proportion to the concession made in case of compromise. In case of rejection being established, the damage shall be limited to payment of freight both ways by the refiner for substitution of an equivalent weight of copper meeting these specifications.

EXPLANATORY NOTE.

These specifications are intended to allow for the fact that the refiner produces copper and gages its quality in furnace charge lots, while the user purchases copper in carload lots, necessarily obtaining a different basis for sampling.

It is intended to cover in these specifications an average grade of copper suitable for all mechanical uses and for making alloys to be used in various wrought forms.

The specifications also recognize the fact that certain shapes are largely put to electrical uses where high electrical conductivity is important.

They do not take into consideration the so-called casting copper used for the purpose of alloying with other metals to produce cast shapes.

[NOTE.—It is to be expected that at the meeting of the International Electrotechnical Commission in 1913, an international agreement will be reached upon a copper conductivity standard, which may be slightly different from the values herein stated.—ED.]

AMERICAN SOCIETY FOR TESTING MATERIALS
PHILADELPHIA, PA., U. S. A.
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INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.

STANDARD SPECIFICATIONS FOR SPELTER.

ADOPTED AUGUST 21, 1911.

1. Under these specifications Virgin Spelter, that is, spelter made from ore or similar raw material by a process of reduction and distillation and not produced from re-worked metal, is considered in four grades, as follows:

A.....High Grade.
B.....Intermediate.
C.....Brass Special.
D.....Prime Western.

Marks. 2. A brand shall be cast in each slab by which the maker and grade can be identified.

Lots. 3. The maker shall use care to have each carload of as uniform quality as possible.

Composition. 4. *A. High Grade.*—The spelter shall not contain over

0.07 per cent. lead.
0.03 " " iron.
0.05 " " cadmium.

It shall be free from aluminum.

The sum of the lead, iron, and cadmium shall not exceed 0.10 per cent.

B. Intermediate.—The spelter shall not contain over

0.20 per cent. lead.
0.03 " " iron.
0.50 " " cadmium.

It shall be free from aluminum.

The sum of the lead, iron, and cadmium shall not exceed 0.50 per cent.

C. Brass Special.—The spelter shall not contain over

0.75 per cent. lead.
0.04 " " iron.
0.75 " " cadmium.

It shall be free from aluminum.

The sum of the lead, iron, and cadmium shall not exceed 1.20 per cent.

D. Prime Western.—The spelter shall not contain over

1.50 per cent. lead.
0.08 " " iron.

Physical. 5. The slabs shall be reasonably free from surface corrosion or adhering foreign matter.

Sampling 6. Not less than ten slabs shall be taken as a sample from each car; for smaller lots, in the same proportion to the total number, but in no case less than three slabs. In case of dispute half of the sample is to be taken by the maker and half by the purchaser; and the whole shall be mixed.

The slabs selected as samples are to be sawed completely across and the sawdust used as a sample. In case no saw is available for this purpose, the slabs should be drilled completely through and the drillings cut up into short lengths. The saw or drill used must be thoroughly cleaned. No lubricant shall be used in either sawing or drilling, and the sawdust or drilling must be carefully treated with a magnet to remove any particles of iron derived from the tools.

Analysis. 7. *Lead.*—For the determination of lead in High Grade not less than 25 grams, in Intermediate not less than 15, in Brass Special not less than 10, and in Prime Western not less than 5 grams, shall be taken; that is, the sample used for analysis should not contain less than 0.01 gram lead.

Iron.—The sample for iron should contain not less than 25 grams for the three higher grades and not less than 10 grams for Prime Western. The entire sample must be dissolved, the iron precipitated as ferric-hydroxide, then re-dissolved, reduced, and the iron determined by titration.

Cadmium.—Dissolve 25 grams in 330 cc. of a solution of one part of hydrochloric acid (specific gravity 1.2) and five parts of water. Let it stand over night; filter and wash; reject filtrate and dissolve the residue, which should be about 5 per cent. of the zinc, in nitric acid. Add 10 cc. of sulphuric acid; evaporate to fumes; dilute and filter out and wash the lead sulphate. Dilute the solution to 500 cc.; add 5 grams of ammonium chloride; pass a slow stream of hydrogen sulphide for one hour and let stand for about five hours; filter, wash with hot water; dissolve in 10 cc. of sulphuric acid and 50 cc. of water; filter and wash. Dilute to 400 cc.; precipitate with hydrogen sulphide as before. Weigh as cadmium sulphide or dissolve in hydrochloric acid and titrate with potassium ferrocyanide.

Claims.

8. Claims to be considered shall be in writing within thirty days of receipt of material at customer's mill and the results of customer's test shall be given. The shipper shall be given one week from date of receipt of such claim to investigate his records and then shall either agree to satisfy the claim or send a representative to the mill.

(*a*) *Analysis by Car Lots.*—No claims shall be considered unless the minimum samples as specified for the grade in question can be shown to such representative.

(*b*) *Physical Defects of Individual Pieces.*—No claims shall be considered unless the spelter in question, unused, can be shown to such representative.

Mill Treatment.

9. Where the spelter satisfies the chemical and physical requirements of these specifications, it shall not be condemned for defects of alloys in which it is used or for defects in the coating of galvanized products.

Investigation of Claims.

10. The maker's representative shall inspect all pieces where physical defects are claimed. If agreement is not reached the question of fact shall be submitted to a mutually agreeable umpire, whose decision shall be final.

On a question of metal contents an adequate sample shall be drawn by the representatives of both parties; the sample shall be prepared from the slabs so selected as described under "Sampling." The sample shall be mixed and separated into three parts, each of which shall be placed in a sealed package, one for each party and one for the umpire if necessary. Each party shall make an analysis and if the results do not establish or dismiss the claim to the satisfaction of both parties, the third sample shall be submitted to a mutually agreeable umpire, who shall determine the question of quality and whose determination shall be final.

Settlement of Claims.

11. The expenses of the maker's representative and of the umpire shall be paid by the loser or divided in proportion to concession made in case of compromise.

In case of rejection being established, damages shall be limited to the payment of freight both ways by the maker for substitution of an equivalent weight of spelter meeting these specifications.

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STANDARD SPECIFICATIONS FOR MANGANESE BRONZE INGOTS.

ADOPTED AUGUST 21, 1911.

General.

1. This specification is intended to cover manganese-bronze ingots, having notched flat bottoms, approximately 3 by $2\frac{3}{4}$ ins. wide by 12 ins. long, properly tapered to strip easily from an iron mold.

Chemical Composition.

2. The chemical composition shall be as follows:

Copper	55 to	60	per cent.
Zinc	39 to	45	" "
Iron	not over	2	" "
Tin	not over	2	" "
Aluminum	not over	0.5	" "
Manganese	not over	0.5	" "

Physical Properties.

3. The ultimate tensile strength shall be not less than 70,000 lbs. per sq. in.

The elongation in 2 ins. shall be not less than 20 per cent.

Test Specimens.

4. The standard turned test specimen, as shown by Fig. 1, 0.5 in. diameter and 2 ins. gauge length, shall be used to determine the physical properties as specified above.

Number and Location of Test of Specimens.

5. One test ingot shall be selected by the inspector to represent 10,000 lbs. of ingots or fraction thereof. The test specimen shall be cut from one corner near the bottom of the ingot. In case the test specimen shows a flaw, two additional tests may be selected by the inspector from the same lot, and tested to represent the lot in question.

Marking.

6. Each furnace charge shall be kept separate until the lot is sampled by the inspector, and each ingot thereof stamped with its proper heat number. When the ingot is sampled at destination, various heats can be mixed in shipment, but must be stamped with their proper heat number.

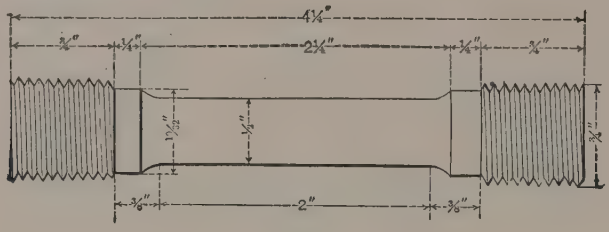

FIG. 1.

Rejections.

7. All ingots in each lot will be rejected upon the physical tests or chemical composition, irrespective of the heat or heats from which the test ingots are selected.

Investigation of Claims.

8. In case the buyer's tests show that the material does not meet these specifications, the seller shall have an opportunity to inspect the material and each party shall select a sample for re-test. If the results do not agree, each shall select a sample to be sent to a mutually agreeable umpire, whose decision shall be final. The costs of such re-tests shall be paid by the loser.

AMERICAN SOCIETY FOR TESTING MATERIALS

PHILADELPHIA, PA., U. S. A.

AFFILIATED WITH THE

INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.

STANDARD SPECIFICATIONS FOR CEMENT.

ADOPTED AUGUST 16, 1909.

GENERAL OBSERVATIONS.

1. These remarks have been prepared with a view of pointing out the pertinent features of the various requirements and the precautions to be observed in the interpretation of the results of the tests.

2. The Committee would suggest that the acceptance or rejection under these specifications be based on tests made by an experienced person having the proper means for making the tests.

SPECIFIC GRAVITY.

3. Specific gravity is useful in detecting adulteration. The results of tests of specific gravity are not necessarily conclusive as an indication of the quality of a cement, but when in combination with the results of other tests may afford valuable indications.

FINENESS.

4. The sieves should be kept thoroughly dry.

TIME OF SETTING.

5. Great care should be exercised to maintain the test pieces under as uniform conditions as possible. A sudden change or wide range of temperature in the room in which the tests are made, a very dry or humid atmosphere, and other irregularities vitally affect the rate of setting.

CONSTANCY OF VOLUME.

6. The tests for constancy of volume are divided into two classes, the first normal, the second accelerated. The latter should be regarded as a precautionary test only, and not infallible. So many conditions enter into the making and interpreting of it that it should be used with extreme care.

7. In making the pats the greatest care should be exercised to avoid initial strains due to molding or to too rapid drying-out during the first twenty-four hours. The pats should be preserved under the most uniform conditions possible, and rapid changes of temperature should be avoided.

8. The failure to meet the requirements of the accelerated tests need not be sufficient cause for rejection. The cement may, however, be held for twenty-eight days, and a retest made at the end of that period, using a new sample. Failure to meet the requirements at this time should be considered sufficient cause for rejection, although in the present state of our knowledge it cannot be said that such failure necessarily indicates unsoundness, nor can the cement be considered entirely satisfactory simply because it passes the tests.

SPECIFICATIONS.

GENERAL CONDITIONS.

1. All cement shall be inspected.

2. Cement may be inspected either at the place of manufacture or on the work.

3. In order to allow ample time for inspecting and testing, the cement should be stored in a suitable weather-tight building having the floor properly blocked or raised from the ground.

4. The cement shall be stored in such a manner as to permit easy access for proper inspection and identification of each shipment.

5. Every facility shall be provided by the Contractor and a period of at least twelve days allowed for the inspection and necessary tests.

6. Cement shall be delivered in suitable packages with the brand and name of manufacturer plainly marked thereon.

7. A bag of cement shall contain 94 pounds of cement net. Each barrel of Portland cement shall contain 4 bags, and each barrel of natural cement shall contain 3 bags of the above net weight.

8. Cement failing to meet the seven-day requirements may be held awaiting the results of the twenty-eight-day tests before rejection.

9. All tests shall be made in accordance with the methods proposed by the Committee on Uniform Tests of Cement of the American Society of Civil Engineers, presented to the Society January 21, 1903, and amended January 20, 1904, and January 15, 1908, with all subsequent amendments thereto. (See addendum to these specifications.)

10. The acceptance or rejection shall be based on the following requirements:

NATURAL CEMENT.

11. *Definition.* This term shall be applied to the finely pulverized product resulting from the calcination of an argillaceous limestone at a temperature only sufficient to drive off the carbonic acid gas.

FINENESS.

12. It shall leave by weight a residue of not more than 10 per cent. on the No. 100, and 30 per cent. on the No. 200 sieve.

TIME OF SETTING.

13. It shall not develop initial set in less than ten minutes; and shall not develop hard set in less than thirty minutes, or in more than three hours.

TENSILE STRENGTH.

14. The minimum requirements for tensile strength for briquettes one square inch in cross section shall be as follows, and the cement shall show no retrogression in strength within the periods specified:

Age.	*Neat Cement.*	*Strength.*
24 hours in moist air		75 lbs.
7 days (1 day in moist air, 6 days in water)		150 "
28 days (1 " " 27 " ")		250 "
	One Part Cement, Three Parts Standard Ottawa Sand.	
7 days (1 day in moist air, 6 days in water)		50 lbs
28 days (1 " " 27 " ")		125 "

CONSTANCY OF VOLUME.

15. Pats of neat cement about three inches in diameter, one-half inch thick at center, tapering to a thin edge, shall be kept in moist air for a period of twenty-four hours.

(*a*) A pat is then kept in air at normal temperature.

(*b*) Another is kept in water maintained as near 70° F. as practicable.

16. These pats are observed at intervals for at least 28 days, and, to satisfactorily pass the tests, shall remain firm and hard and show no signs of distortion, checking, cracking, or disintegrating.

PORTLAND CEMENT.

17. *Definition.* This term is applied to the finely pulverized product resulting from the calcination to incipient fusion of an intimate mixture of properly proportioned argillaceous and calcareous materials, and to which no addition greater than 3 per cent. has been made subsequent to calcination.

SPECIFIC GRAVITY.

18. The specific gravity of cement shall not be less than 3.10. Should the test of cement as received fall below this requirement, a second test may be made upon a sample ignited at a low red heat. The loss in weight of the ignited cement shall not exceed 4 per cent.

FINENESS.

19. It shall leave by weight a residue of not more than 8 per cent. on the No. 100, and not more than 25 per cent. on the No. 200 sieve.

TIME OF SETTING.

20. It shall not develop initial set in less than thirty minutes; and must develop hard set in not less than one hour, nor more than ten hours.

TENSILE STRENGTH.

21. The minimum requirements for tensile strength for briquettes one square inch in cross section shall be as follows, and

the cement shall show no retrogression in strength within the periods specified:

Age.	*Neat Cement.*	*Strength.*
24 hours	in moist air	175 lbs.
7 days	(1 day in moist air, 6 days in water)	500 "
28 days	(1 " " " 27 " ")	600 "

One Part Cement, Three Parts Standard Ottawa Sand.		
7 days	(1 day in moist air, 6 days in water)	200 lbs.
28 days	(1 " " " 27 " ")	275 "

CONSTANCY OF VOLUME.

22. Pats of neat cement about three inches in diameter, one-half inch thick at the center, and tapering to a thin edge, shall be kept in moist air for a period of twenty-four hours.

(*a*) A pat is then kept in air at normal temperature and observed at intervals for at least 28 days.

(*b*) Another pat is kept in water maintained as near 70° F. as practicable, and observed at intervals for at least 28 days.

(*c*) A third pat is exposed in any convenient way in an atmosphere of steam, above boiling water, in a loosely closed vessel for five hours.

23. These pats, to satisfactorily pass the requirements, shall remain firm and hard, and show no signs of distortion, checking, cracking, or disintegrating.

SULPHURIC ACID AND MAGNESIA.

24. The cement shall not contain more than 1.75 per cent. of anhydrous sulphuric acid (SO_3), nor more than 4 per cent. of magnesia (MgO).

ADDENDUM.

METHODS FOR TESTING CEMENT.[1]

RECOMMENDED BY THE SPECIAL COMMITTEE ON UNIFORM TESTS OF CEMENT OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS.

SAMPLING.

1. *Selection of Sample.*—The selection of samples for testing should be left to the engineer. The number of packages sampled and the quantity taken from each package will depend on the importance of the work and the facilities for making the tests.

2. The samples should fairly represent the material. When the amount to be tested is small it is recommended that one barrel in ten be sampled; when the amount is large it may be impracticable to take samples from more than one barrel in thirty or fifty. When the samples are taken from bins at the mill one for each fifty to two hundred barrels will suffice.

3. Samples should be passed through a sieve having twenty meshes per linear inch, in order to break up lumps and remove foreign material; the use of this sieve is also effective to obtain a thorough mixing of the samples when this is desired. To determine the acceptance or rejection of cement it is preferable, when time permits, to test the samples separately. Tests to determine the general characteristics of a cement, extending over a long period, may be made with mixed samples.

4. *Method of Sampling.*—Cement in barrels should be sampled through a hole made in the head, or in one of the staves midway between the heads, by means of an auger or a sampling iron similar to that used by sugar inspectors; if in bags, the sample should be taken from surface to center; cement in bins should be sampled in such a manner as to represent fairly the contents of the bin. Sampling from bins is not recommended if the method of manufacture is such that ingredients of any kind are added to the cement subsequently.

CHEMICAL ANALYSIS.

5. *Significance.*—Chemical analysis may serve to detect adulteration of cement with inert material, such as slag or ground limestone, if in considerable amount. It is useful in determining whether certain constituents, such as magnesia and sulphuric anhydride, are present in inadmissible proportions.

6. The determination of the principal constituents of cement, silica, alumina, iron oxide, and lime, is not conclusive as an indication of quality. Faulty cement results more frequently from imperfect preparation of the raw

[1] Accompanying Final Report of Special Committee on Uniform Tests of Cement of the American Society of Civil Engineers, dated January 17, 1912.

material or defective burning than from incorrect proportions. Cement made from material ground very finely and thoroughly burned may contain much more lime than the amount usually present, and still be perfectly sound. On the other hand, cements low in lime may, on account of careless preparation of the raw material, be of dangerous character. Furthermore, the composition of the product may be so greatly modified by the ash of the fuel used in burning as to affect in a great degree the significances of the results of analysis.

7. *Methods.*—The methods to be followed, except for determining the loss on ignition, should be those proposed by the Committee on Uniformity in the Analysis of Materials for the Portland Cement Industry, reported in the *Journal of the Society for Chemical Industry*, Vol. 21, page 12, 1902; and published in *Engineering News*, Vol. 50, p. 60, 1903; and in *Engineering Record*, Vol. 48, p. 49, 1903, and in addition thereto, the following:

(*a*) The insoluble residue may be determined as follows: To a 1-g. sample of the cement are added 30 cc. of water and 10 cc. of concentrated hydrochloric acid, and then warmed until effervescence ceases, and digested on a steam bath until dissolved. The residue is filtered, washed with hot water, and the filter paper and contents digested on the steam bath in a 5-per cent solution of sodium carbonate. This residue is filtered, washed with hot water, then with hot hydrochloric acid, and finally with hot water, and then ignited at a red heat and weighed. The quantity so obtained is the insoluble residue.

(*b*) The loss on ignition shall be determined in the following manner: One-half gramme of cement is heated in a weighed platinum crucible, with cover, for 5 min. with a Bunsen burner (starting with a low flame and gradually increasing to its full height) and then heated for 15 min. with a blast lamp; the difference between the weight after cooling and the original weight is the loss on ignition. The temperature should not exceed 900° C., or a low red heat; the ignition should preferably be made in a muffle.

SPECIFIC GRAVITY.

8. *Significance.*—The specific gravity of cement is lowered by adulteration and hydration, but the adulteration must be considerable to be detected by tests of specific gravity.

9. Inasmuch as the differences in specific gravity are usually very small, great care must be exercised in making the determination.

10. *Apparatus.*—The determination of specific gravity should be made with a standardized Le Chatelier apparatus. This consists of a flask (*D*), Fig. 1, of about one hundred and twenty cubic centimeters capacity, the neck of which is about twenty centimeters long; in the middle of this neck is a bulb (*C*), above and below which are two marks (*F*) and (*E*); the volume between these two marks is 20 cc. The neck has a diameter of about nine millimeters, and is graduated into tenths of cublic centimeters above the mark (*F*).

11. Benzine (62° Beaumé naphtha) or kerosene free from water should be used in making the determination.

12. *Method.*—The flask is filled with either of these liquids to the lower mark (*E*), and 64 g. of cement, cooled to the temperature of the liquid, is slowly introduced through the funnel (*B*), (the stem of which should be long enough to extend into the flask to the top of the bulb (*C*)), taking care that the cement does not adhere to the sides of the flask, and that the funnel does not touch the liquid. After all the cement is introduced, the level of the liquid

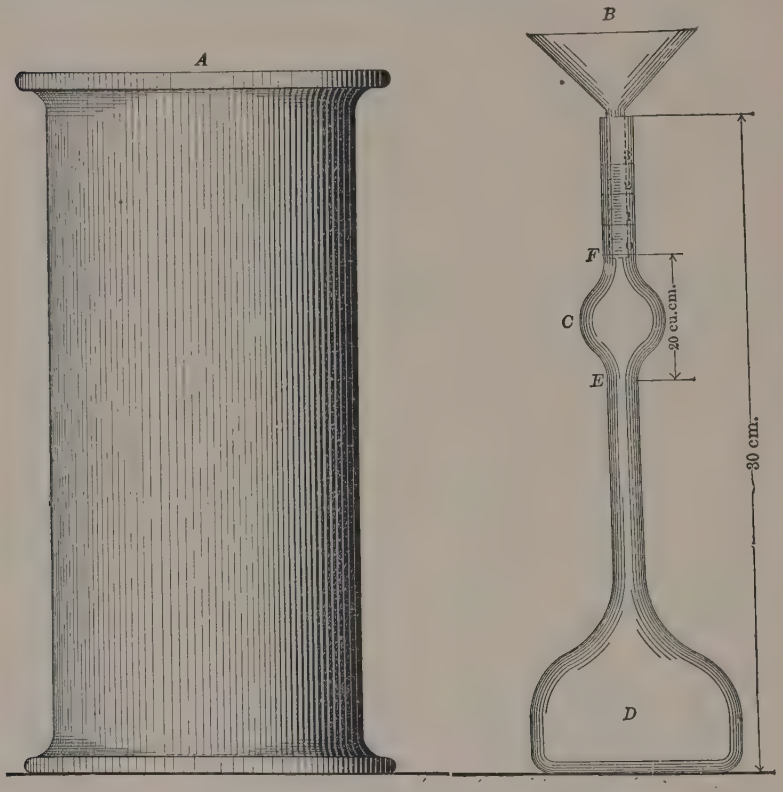

FIG. 1.—Le Chatelier's Specific Gravity Apparatus.

will rise to some division of the graduated neck; this reading, plus 20 cc., is the volume displaced by 64 g. of the cement.

13. The specific gravity is then obtained from the formula,

$$\text{Specific gravity} = \frac{\text{Weight of cement, in grammes,}}{\text{Displaced volume, in cubic centimeters.}}$$

14. The flask, during the operation, is kept immersed in water in a jar (*A*), in order to avoid variations in the temperature of the liquid in the flask,

which should not exceed $\frac{1}{2}$° C. The results of repeated tests should agree within 0.01. The determination of specific gravity should be made on the cement as received; if it should fall below 3.10, a second determination should be made after igniting the sample in a covered dish, preferably of platinum, at a low red heat not exceeding 900° C. The sample should be heated for 5 min. with a Bunsen burner (starting with a low flame and gradually increasing to its full height) and then heated for 15 min. with a blast lamp; the ignition should preferably be made in a muffle.

15. The apparatus may be cleaned in the following manner: The flask is inverted and shaken vertically until the liquid flows freely, and then held in a vertical position until empty; any traces of cement remaining can be removed by pouring into the flask a small quantity of clean liquid benzine or kerosene and repeating the operation.

FINENESS.

16. *Significance.*—It is generally accepted that the coarser particles in cement are practically inert, and it is only the extremely fine powder that possesses cementing qualities. The more finely cement is pulverized, other conditions being the same, the more sand it will carry and produce a mortar of a given strength.

17. *Apparatus.*—The fineness of a sample of cement is determined by weighing the residue retained on certain sieves. Those known as No. 100 and No. 200, having approximately 100 and 200 wires per linear inch, respectively, should be used. They should be 8 in. in diameter. The frame should be of brass, 8 in. in diameter, and the sieve of brass wire cloth conforming to the following requirements:

No. of sieve.	Diameter of wire, inches.	MESHES, PER LINEAR INCH.	
		Warp.	Woof.
100	0.0042 to 0.0048	95 to 101	93 to 103
200	0.0021 to 0.0023	192 to 203	190 to 205

The meshes in any smaller space, down to 0.25 in., should be proportional in number.

18. *Method.*—The test should be made with 50 g. of cement, dried at a temperature of 100° C. (212° F.).

19. The cement is placed on the No. 200 sieve, which, with pan and cover attached, is held in one hand in a slightly inclined position, and moved forward and backward about 200 times per minute, at the same time striking the side gently, on the up stroke, against the palm of the other hand. The operation is continued until not more than 0.05 g. will pass through in 1 min. The residue is weighed, then placed on the No. 100 sieve, and the operation repeated. The work may be expedited by placing in the sieve a few large steel shot, which should be removed before the final 1 min. of sieving. The sieves should be thoroughly dry and clean.

NORMAL CONSISTENCY.

20. *Significance.*—The use of a proper percentage of water in making pastes[1] and mortars for the various tests is exceedingly important and affects vitally the results obtained.

21. The amount of water, expressed in percentage by weight of the dry cement, required to produce a paste of plasticity desired, termed "normal

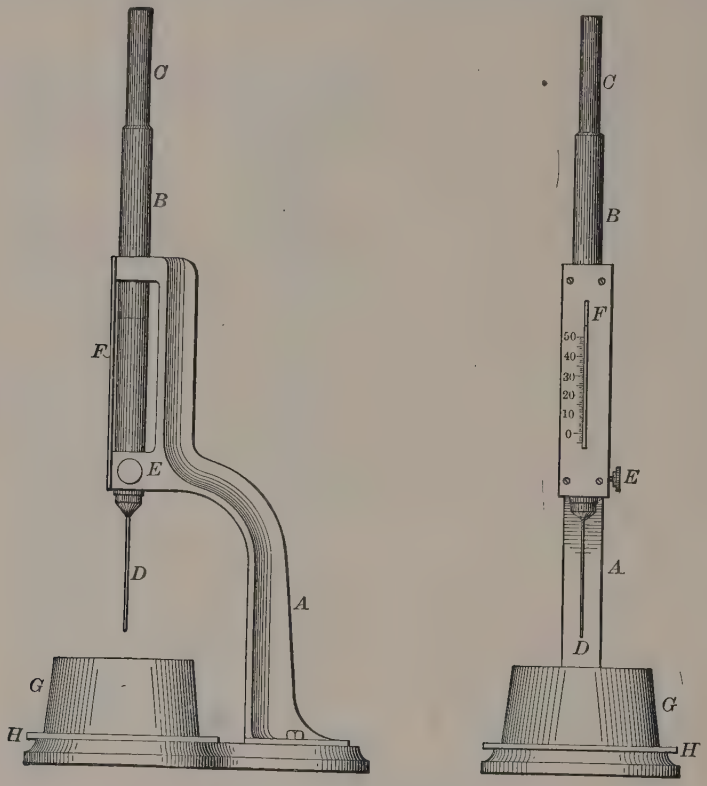

FIG. 2.—Vicat Apparatus.

consistency," should be determined with the Vicat apparatus in the following manner:

22. *Apparatus.*—This consists of a frame (*A*), Fig. 2, bearing a movable rod (*B*), weighing 300 g., one end (*C*) being 1 cm. in diameter for a distance of 6 cm., the other having a removable needle (*D*), 1 mm. in diameter, 6 mm. long. The rod is reversible, and can be held in any desired position by

[1] The term "paste" is used in this report to designate a mixture of cement and water, and the word "mortar" to designate a mixture of cement, sand, and water.

a screw (*E*), and has midway between the ends a mark (*F*) which moves under a scale (graduated to millimeters) attached to the frame (*A*). The paste is held in a conical, hard-rubber ring (*G*), 7 cm. in diameter at the base, 4 cm. high, resting on a glass plate (*H*) about 10 cm. square.

23. *Method.*—In making the determination, the same quantity of cement as will be used subsequently for each batch in making the test pieces, but not less than 500 g., with a measured quantity of water, is kneaded into a paste, as described in Paragraph 45, and quickly formed into a ball with the hands, completing the operation by tossing it six times from one hand to the other, maintained about 6 in. apart; the ball resting in the palm of one hand is pressed into the larger end of the rubber ring held in the other hand, completely filling the ring with paste; the excess at the larger end is then removed by a single movement of the palm of the hand; the ring is then placed on its larger end on a glass plate and the excess paste at the smaller end is sliced off at the top of the ring by a single oblique stroke of a trowel held at a slight angle with the top of the ring. During these operations care must be taken not to compress the paste. The paste confined in the ring, resting on the plate, is placed under the rod, the larger end of which is brought in contact with the surface of the paste; the scale is then read, and the rod quickly released.

24. The paste is of normal consistency when the cylinder settles to a point 10 mm. below the original surface in one-half minute after being released. The apparatus must be free from all vibrations during the test.

25. Trial pastes are made with varying percentages of water until the normal consistency is obtained.

26. Having determined the percentage of water required to produce a paste of normal consistency, the percentage required for a mortar containing, by weight, one part of cement to three parts of standard Ottawa sand, is obtained from the following table, the amount being a percentage of the combined weight of the cement and sand.

PERCENTAGE OF WATER FOR STANDARD MORTARS.

Neat.	One cement, three standard Ottawa sand.	Neat.	One cement, three standard Ottawa sand.	Neat.	One cement, three standard Ottawa sand.
15	8.0	23	9.3	31	10.7
16	8.2	24	9.5	32	10.8
17	8.3	25	9.7	33	11.0
18	8.5	26	9.8	34	11.2
19	8.7	27	10.0	35	11.3
20	8.8	28	10.2	36	11.5
21	9.0	29	10.3	37	11.7
22	9.2	30	10.5	38	11.8

TIME OF SETTING.

27. *Significance.*—The object of this test is to determine the time which elapses from the moment water is added until the paste ceases to be plastic (called the "initial set"), and also the time until it acquires a certain degree of hardness (called the "final set" or "hard set"). The former is the

more important, since, with the commencement of setting, the process of crystallization begins. As a disturbance of this process may produce a loss of strength, it is desirable to complete the operation of mixing or molding or incorporating the mortar into the work before the cement begins to set.

28. *Apparatus.*—The initial and final set should be determined with the Vicat apparatus described in Paragraph 22.

29. *Method.*—A paste of normal consistency is molded in the hard-rubber ring, as described in Paragraph 23, and placed under the rod (*B*), the smaller end of which is then carefully brought in contact with the surface of the paste, and the rod quickly released.

30. The initial set is said to have occurred when the needle ceases to pass a point 5 mm. above the glass plate; and the final set, when the needle does not sink visibly into the paste.

31. The test pieces should be kept in moist air during the test; this may be accomplished by placing them on a rack over water contained in a pan and covered by a damp cloth; the cloth to be kept from contact with them by means of a wire screen; or they may be stored in a moist box or closet.

32. Care should be taken to keep the needle clean, as the collection of cement on the sides of the needle retards the penetration, while cement on the point may increase the penetration.

33. The time of setting is affected not only by the percentage and temperature of the water used and the amount of kneading the paste receives, but by the temperature and humidity of the air, and its determination is, therefore, only approximate.

STANDARD SAND.

34. The sand to be used should be natural sand from Ottawa, Ill., screened to pass a No. 20 sieve, and retained on a No. 30 sieve. The sieves should be at least 8 in. in diameter; the wire cloth should be of brass wire and should conform to the following requirements:

No. of sieve.	Diameter of wire, inches.	Meshes, per Linear Inch.	
		Warp.	Woof.
20	0.016 to 0.017	19.5 to 20.5	19 to 21
30	0.011 to 0.012	29.5 to 30.5	28.5 to 31.5

Sand which has passed the No. 20 sieve is standard when not more than 5 g. passes the No. 30 sieve in 1 min. of continuous sifting of a 500-g. sample.[1]

FORM OF TEST PIECES.

35. For tensile tests the form of test piece shown in Fig. 3 should be used.

36. For compressive tests, 2-in. cubes should be used.

[1] This sand may now (1912) be obtained from the Ottawa Silica Co., at a cost of two cents per pound, f. o. b. cars, Ottawa, Ill

MOLDS.

37. The molds should be of brass, bronze, or other non-corrodible material, and should have sufficient metal in the sides to prevent spreading during molding.

38. Molds may be either single or gang molds. The latter are pre

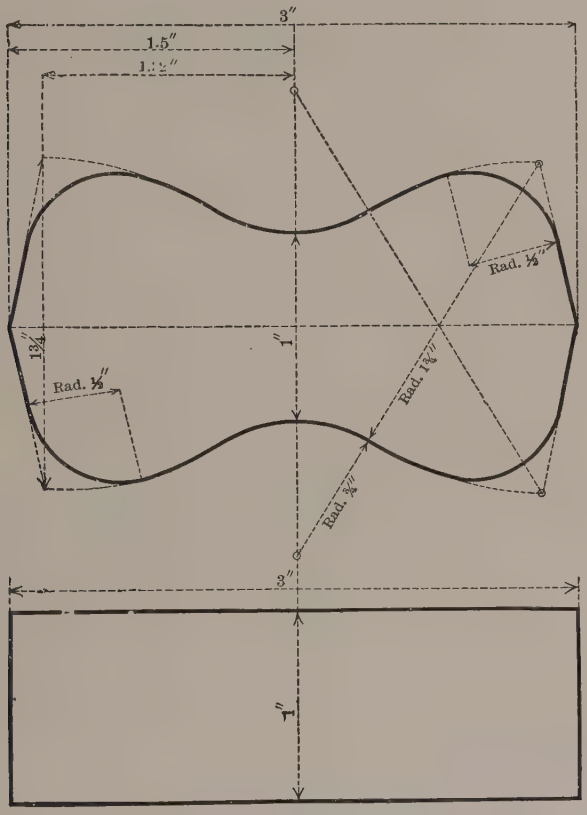

FIG. 3.—Details for Briquette.

ferred by many. If used, the types shown in Figs. 4 and 5 are recommended.

39. The molds should be wiped with an oily cloth before using.

MIXING.

40. The proportions of sand and cement should be stated by weight: the quantity of water should be stated as a percentage by weight of the dry material.

41. The metric system is recommended because of the convenient relation of the gramme and the cubic centimeter.

42. The temperature of the room and of the mixing water should be maintained as nearly as practicable at 21° C. (70° F.).

43. The quantity of material to be mixed at one time depends on the number of test pieces to be made; 1000 grammes is a convenient quantity to mix by hand methods.

44. The Committee has investigated the various mechanical mixing machines thus far devised, but cannot recommend any of them, for the following reasons: (1) the tendency of most cement is to "ball up" in the machine, thereby preventing working it into a homogeneous paste; (2) there are no means of ascertaining when the mixing is complete without stopping the machine; and (3) it is difficult to keep the machine clean.

45. *Method.*—The material is weighed, placed on a non-absorbent

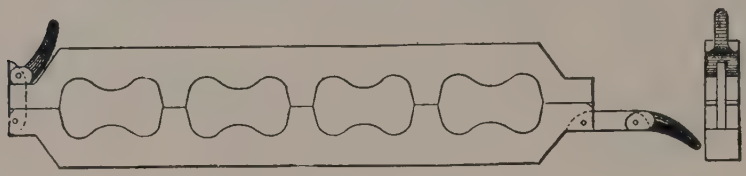

FIG. 4.—Details for Gang Mold.

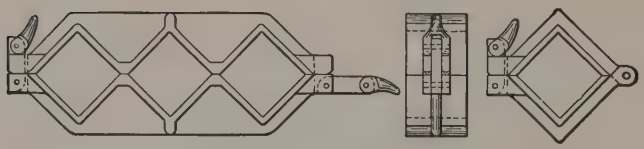

FIG. 5.—Mold for Compression Test Pieces.

surface (preferably plate glass), thoroughly mixed dry if sand be used, and a crater formed in the center, into which the proper percentage of clean water is poured; the material on the outer edge is turned into the center by the aid of a trowel. As soon as the water has been absorbed, which should not require more than one minute, the operation is completed by vigorously kneading with the hands for 1 min. During the operation the hands should be protected by rubber gloves.

MOLDING.

46. The Committee has not been able to secure satisfactory results with existing molding machines; the operation of machine molding is very slow; and is not practicable with pastes or mortars containing as large percentages of water as herein recommended.

47. *Method.*—Immediately after mixing, the paste or mortar is placed in the molds with the hands, pressed in firmly with the fingers, and smoothed

off with a trowel without ramming. The material should be heaped above the mold, and, in smoothing off, the trowel should be drawn over the mold in such a manner as to exert a moderate pressure on the material. The mold should then be turned over and the operation of heaping and smoothing off repeated.

48. A check on the uniformity of mixing and molding may be afforded

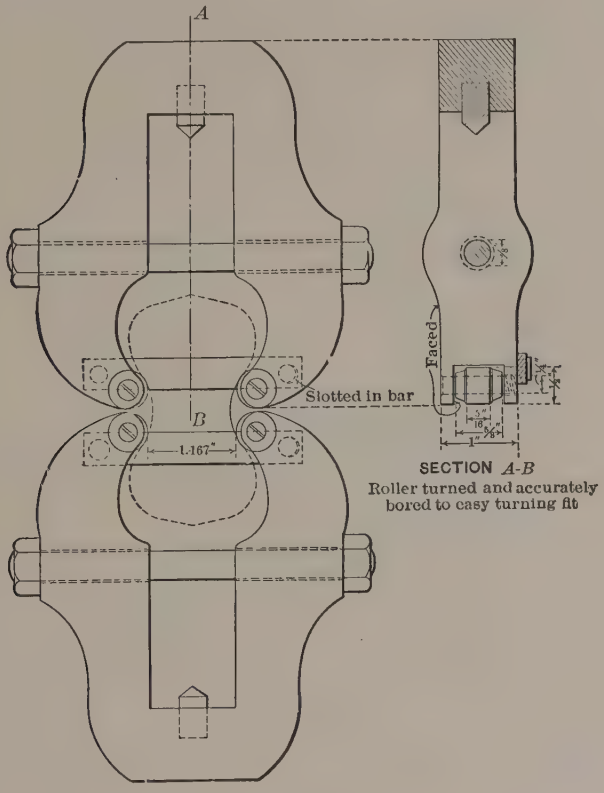

FIG. 6.—Form of Clip.

by weighing the test pieces on removal from the moist closet; test pieces from any sample which vary in weight more than 3 per cent from the average should not be considered.

STORAGE OF THE TEST PIECES.

49. During the first 24 hr. after molding, the test pieces should be kept in moist air to prevent drying.

50. Two methods are in common use to prevent drying: (1) covering

the test pieces with a damp cloth, and (2) placing them in a moist closet. The use of the damp cloth, as usually carried out, is objectionable, because the cloth may dry out unequally and in consequence the test pieces will not all be subjected to the same degree of moisture. This defect may be remedied to some extent by immersing the edges of the cloth in water; contact between the cloth and the test pieces should be prevented by means of a wire screen, or some similar arrangement. A moist closet is so much more effective in securing uniformly moist air, and is so easily devised and so inexpensive, that the use of the damp cloth should be abandoned.

51. A moist closet consists of a soapstone or slate box, or a wooden box lined with metal, the interior surface being covered with felt or broad wicking kept wet, the bottom of the box being kept covered with water. The interior of the box is provided with glass shelves on which to place the test pieces, the shelves being so arranged that they may be withdrawn readily.

52. After 24 hr. in moist air, the pieces to be tested after longer periods should be immersed in water in storage tanks or pans made of non-corrodible material.

53. The air and water in the moist closet and the water in the storage tanks should be maintained as nearly as practicable at 21° C. (70° F.).

TENSILE STRENGTH.

54. The tests may be made with any standard machine.

55. The clip is shown in Fig. 6. It must be made accurately, the pins and rollers turned, and the rollers bored slightly larger than the pins so as to turn easily. There should be a slight clearance at each end of the roller, and the pins should be kept properly lubricated and free from grit. The clips should be used without cushioning at the points of contact.

56. Test pieces should be broken as soon as they are removed from the water. Care should be observed in centering the test pieces in the testing machine, as cross strains, produced by imperfect centering, tend to lower the breaking strength. The load should not be applied too suddenly, as it may produce vibration, the shock from which often causes the test pieces to break before the ultimate strength is reached. The bearing surfaces of the clips and test pieces must be kept free from grains of sand or dirt, which would prevent a good bearing. The load should be applied at the rate of 600 lb. per min. The average of the results of the test pieces from each sample should be taken as the test of the sample. Test pieces which do not break within $\frac{1}{4}$ in. of the center, or are otherwise manifestly faulty, should be excluded in determining average results.

COMPRESSIVE STRENGTH.

57. The tests may be made with any machine provided with means for so applying the load that the line of pressure is along the axis of the test piece. A ball-bearing block for this purpose is shown in Fig. 7. Some appliance should be provided to facilitate placing the axis of the test piece exactly in line with the center of the ball-bearing.

58. The test piece should be placed in the testing machine, with a piece of heavy blotting paper on each of the crushing faces, which should be those that were in contact with the mold.

CONSTANCY OF VOLUME.

59. *Significance.*—The object is to detect those qualities which tend to destroy the strength and durability of a cement. Under normal conditions these defects will in some cases develop quickly, and in other cases may not

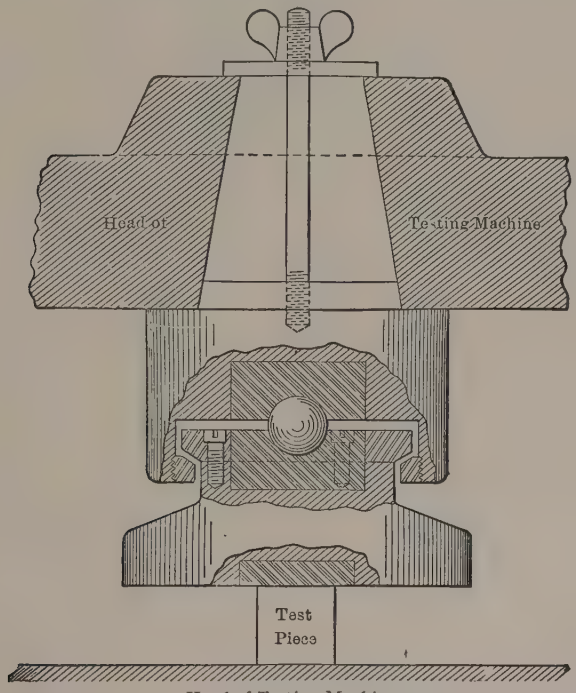

FIG. 7.—Ball-bearing Block for Testing Machine.

develop for a considerable time. Since the detection of these destructive qualities before using the cement in construction is essential, tests are made not only under normal conditions but under artificial conditions created to hasten the development of these defects. Tests may, therefore, be divided into two classes: (1) Normal tests, made in either air or water maintained, as nearly as practicable, at 21° C. (70° F.); and (2) Accelerated tests, made in air, steam or water, at temperature of 45° C. (113° F.) and upward. The Committee recommends that these tests be made in the following manner:

60. *Methods.*—Pats, about three inches in diameter, one-half inch thick

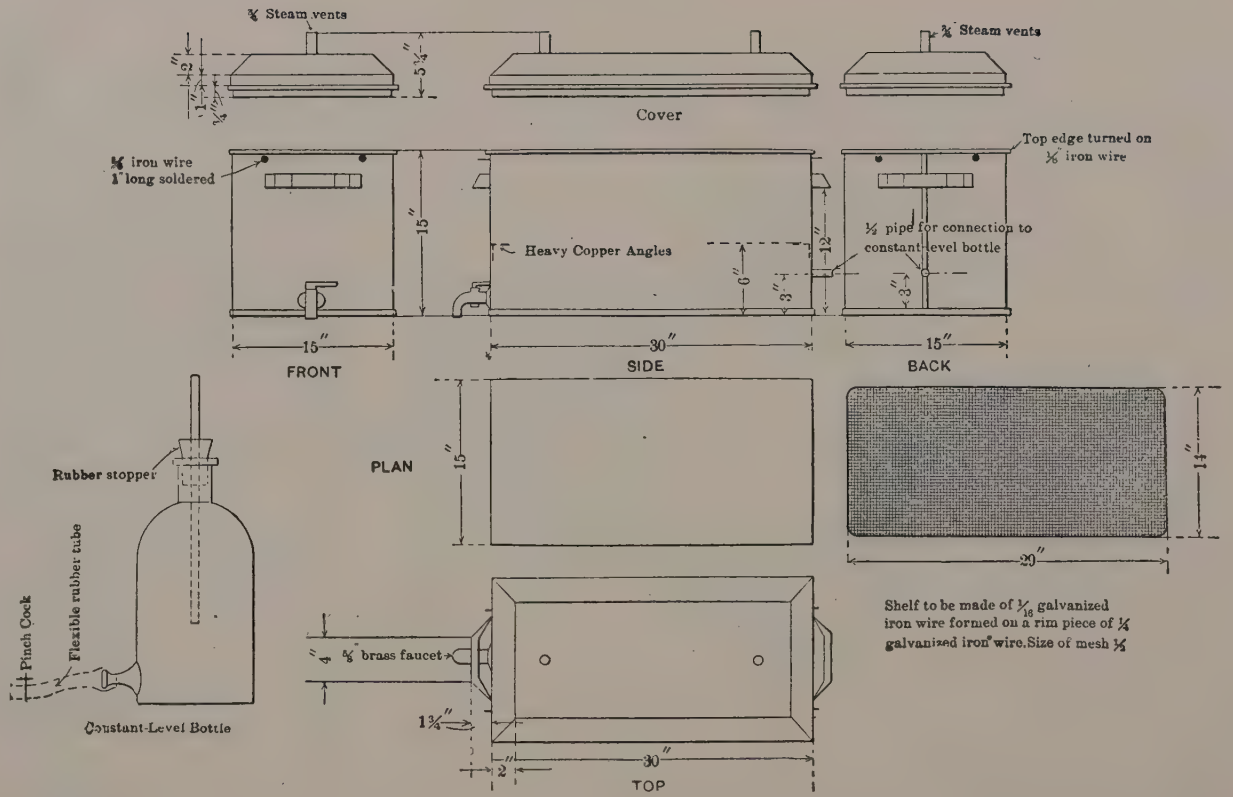

FIG. 8.—Apparatus for Making Accelerated Test for Soundness of Cement.

To be made of sheet copper weighing 22 oz. per sq. ft., tinned inside.
All seams to be lapped where possible. Hard solder only to be used.

at the center, and tapering to a thin edge, should be made on clean glass plates (about four inches square) from cement paste of normal consistency, and stored in a moist closet for 24 hr.

61. *Normal Tests.*—After 24 hr. in the moist closet, a pat is immersed in water for 28 days and observed at intervals. A similar pat, after 24 hr. in the moist closet, is exposed to the air for 28 days or more and observed at intervals.

62. *Accelerated Test.*—After 24 hr. in the moist closet, a pat is placed in an atmosphere of steam, upon a wire screen 1 in. above boiling water, for 5 hr. The apparatus should be so constructed that the steam will escape freely and atmospheric pressure be maintained. Since the type of apparatus used has a great influence on the results, the arrangement shown in Fig. 8 is recommended.

63. Pats which remain firm and hard and show no signs of cracking, distortion, or disintegration are said to be "of constant volume" or "sound."

64. Should the pat leave the plate, distortion may be detected best with a straight-edge applied to the surface which was in contact with the plate.

65. In the present state of our knowledge it cannot be said that a cement which fails to pass the acclerated test will prove defective in the work; nor can a cement be considered entirely safe simply because it has passed these tests.

METHODS FOR TESTING CEMENT.[1]

CONDENSED FOR USE IN SPECIFICATIONS.

1. SAMPLING.

Cement in barrels shall be sampled through a hole made in the head, or in one of the staves midway between the heads, by means of an auger or a sampling iron similar to that used by sugar inspectors; if in bags, the sample shall be taken from surface to center. Cement in bins shall be sampled in such a manner as to represent fairly the contents of the bin. The number of samples taken shall be as directed by the engineer, who will determine whether the samples shall be tested separately or mixed.

The samples shall be passed through a sieve having twenty meshes per linear inch, in order to break up lumps and remove foreign material.

2. CHEMICAL ANALYSIS.

The methods to be followed, except for determining the loss on ignition should be those proposed by the Committee on Uniformity in the Analysis of Materials for the Portland Cement Industry, reported in the *Journal of the Society for Chemical Industry*, Vol. 21, p. 12, 1902, and published in *Engineering News*, Vol. 50, p. 60, 1903, and in *Engineering Record*, Vol. 48, p. 49, 1903, and in addition thereto the following:

(*a*) The insoluble residue may be determined as follows: To a 1-g. sample of the cement are added 30 cc. of water and 10 cc. of concentrated hydrochloric acid, and then warmed until effervescence ceases, and digested on a steam bath until dissolved. The residue is filtered, washed with hot water, and the filter paper and contents digested on the steam bath in a 5-per cent solution of sodium carbonate. This residue is filtered, washed with hot water, then with hot hydrochloric acid, and finally with hot water, and then ignited at a red heat and weighed. The quantity so obtained is the insoluble residue.

(*b*) The loss on ignition shall be determined in the following manner: One-half gramme of cement is heated in a weighed platinum crucible, with cover, for 5 min. with a Bunsen burner (starting with a low flame and gradually increasing to its full height) and then heated for 15 min. with a blast lamp; the difference between the weight after cooling and the original weight is the loss on ignition. The temperature should not exceed 900° C., or a low red heat; the ignition should preferably be made in a muffle.

3. SPECIFIC GRAVITY.

The determination of specific gravity shall be made with a standardized Le Chatelier apparatus. This consists of a flask (*D*), Fig. 1, page 308, of about

[1] Accompanying Final Report of Special Committee on Uniform Tests of Cement of the American Society of Civil Engineers, dated January 17, 1912.

one hundred and twenty cubic centimeters capacity, the neck of which is about twenty centimeters long; in the middle of this neck is a bulb (*C*), above and below which are two marks (*F*) and (*E*); the volume between these two marks is 20 cc. The neck has a diameter of nine millimeters, and is graduated into tenths of cubic centimeters above the mark (*F*).

Benzine (62° Beaumé naphtha) or kerosene free from water shall be used in making the determination. The flask is filled with either of these liquids to the lower mark (*E*) and 64 g. of cement, cooled to the temperature of the liquid, is slowly introduced through the funnel (*B*), (the stem of which should be long enough to extend into the flask to the top of the bulb (*C*),) taking care that the cement does not adhere to the sides of the flask, and that the funnel does not touch the liquid. After all the cement is introduced, the level of the liquid will rise to some division of the graduated neck; this reading, plus 20 cc., is the volume displaced by 64 g. of the cement. The specific gravity is obtained from the formula,

$$\text{Specific gravity} = \frac{\text{Weight of cement, in grammes,}}{\text{Displaced volume, in cubic centimeters.}}$$

The flask, during the operation, is kept immersed in water in a jar (*A*) in order to avoid variations in the temperature of the liquid in the flask, which shall not exceed ½° C. The results of repeated tests shall agree within 0.01. The determination of specific gravity shall be made on the cement as received; if it should fall below 3.10, a second determination shall be made after igniting the sample in a covered dish, preferably of platinum, at a low red heat not exceeding 900° C. The sample shall be heated for 5 min. with a Bunsen burner (starting with a low flame and gradually increasing to its full height) and then heated for 15 min. with a blast lamp; the ignition should preferably be made in a muffle.

4. FINENESS.

The fineness shall be determined by weighing the residue retained on No. 100 and No. 200 sieves. The sieves, 8 in. in diameter, shall be of brass wire cloth conforming to the following requirements:

No. of sieve.	Diameter of wire, inches.	Meshes, per Linear Inch.	
		Warp.	Woof.
100	0.0042 to 0.0048	95 to 101	93 to 103
200	0.0021 to 0.0023	192 to 203	190 to 205

The meshes in any smaller space, down to 0.25 in., shall be proportional in number.

Fifty grammes of cement, dried at a temperature of 100° C. (212° F.) shall be placed on the No. 200 sieve, which, with pan and cover attached, is

held in one hand in a slightly inclined position, and moved forward and backward about 200 times per minute, at the same time striking the side gently, on the up stroke, against the palm of the other hand. The operation is continued until not more than 0.05 g. will pass through in 1 min. The residue is weighed, then placed on the No. 100 sieve, and the operation repeated. The work may be expedited by placing in the sieve a few large steel shot, which should be removed before the final 1 min. of sieving. The sieves should be thoroughly dry and clean.

5. NORMAL CONSISTENCY.

The amount of water, expressed in percentage by weight of the dry cement, required to produce a paste[1] of the plasticity desired, termed "normal consistency," shall be determined with the Vicat apparatus:

This consists of a frame (*A*), Fig. 2, page 310, bearing a movable rod (*B*), weighing 300 g., one end (*C*) being 1 cm. in diameter for a distance of 6 cm., the other having a removable needle (*D*), 1 mm. in diameter, 6 cm. long. The rod is reversible, and can be held in any desired position by a screw (*E*), and has midway between the ends a mark (*F*) which moves under a scale (graduated to millimeters) attached to the frame (*A*). The paste is held in a conical, hard-rubber ring (*G*), 7 cm. in diameter at the base, 4 cm. high, resting on a glass plate (*H*) about ten centimeters square.

In making the determination of normal consistency, the same quantity of cement as will be used subsequently for each batch in making the test pieces, but not less than 500 g., together with a measured amount of water, is kneaded into a paste, as described in Section 9, and quickly formed into a ball with the hands, completing the operation by tossing it six times from one hand to the other, maintained about six inches apart; the ball resting in the palm of one hand is pressed into the larger end of the rubber ring held in the other hand, completely filling the ring with paste; the excess at the larger end is then removed by a single movement of the palm of the hand; the ring is then placed on its larger end on a glass plate and the excess paste at the smaller end is sliced off at the top of the ring by a single oblique stroke of a trowel held at a slight angle with the top of the ring. During these operations care must be taken not to compress the paste. The paste confined in the ring, resting on the plate, is placed under the rod, the larger end of which is carefully brought in contact with the surface of the paste; the scale is then read, and the rod quickly released.

The paste is of normal consistency when the cylinder settles to a point 10 mm. below the original surface in $\frac{1}{2}$ min. after being released. The apparatus must be free from all vibrations during the test.

Trial pastes are made with varying percentages of water until the normal consistency is attained.

Having determined the percentage of water required to produce a paste of normal consistency, the percentage required for a mortar containing, by

[1] The term "paste" is used in these specifications to designate a mixture of cement and water, and the word "mortar" to designate a mixture of cement, sand, and water.

weight, one part of cement to three parts of standard Ottawa sand, shall be obtained from the following table, the amount being a percentage of the combined weight of the cement and sand.

PERCENTAGE OF WATER FOR STANDARD MORTARS.

Neat.	One cement, three standard Ottawa sand.	Neat.	One cement, three standard Ottawa sand.	Neat.	One cement, three standard Ottawa sand.
15	8.0	23	9.3	31	10.7
16	8.2	24	9.5	32	10.8
17	8.3	25	9.7	33	11.0
18	8.5	26	9.8	34	11.2
19	8.7	27	10.0	35	11.3
20	8.8	28	10.2	36	11.5
21	9.0	29	10.3	37	11.7
22	9.2	30	10.5	38	11.8

6. TIME OF SETTING.

The time of setting shall be determined with the Vicat apparatus in the following manner:

A paste of normal consistency is molded in the hard-rubber ring, as described in Section 5, and placed under the rod (*B*), the smaller end of which is then carefully brought in contact with the surface of the paste, and the rod quickly released.

The cement is considered to have acquired its initial set when the needle ceases to pass a point 5 mm. above the glass plate; and the final set, when the needle does not sink visibly into the paste.

The test pieces must be kept in moist air during the test.

7. STANDARD SAND.

The sand shall be natural sand from Ottawa, Ill., screened to pass a No. 20 sieve, and retained on a No. 30 sieve.

The sieves shall be at least 8 in. in diameter, and the wire cloth shall be of brass wire and shall conform to the following requirements:

No. of sieve.	Diameter of wire, inches.	MESHES, PER LINEAR INCH.	
		Warp.	Woof.
20	0.016 to 0.017	19.5 to 20.5	19 to 21
30	0.011 to 0.012	29.5 to 30.5	28.5 to 31.5

Sand which has passed the No. 20 sieve is standard when not more than 5 g. passes the No. 30 sieve in 1 min. of continuous sifting of a 500-g. sample.[1]

[1] This sand may now (1912) be obtained from the Ottawa Silica Co., at a cost of two cents per pound, f. o. b. cars, Ottawa, Ill.

8. FORM OF TEST PIECES.

For tensile tests, the form of test pieces shown in Fig. 3, page 313, shall be used.

For compressive tests, 2-in. cubes shall be used.

9. MIXING AND MOLDING.

The material shall be weighed, placed on a non-absorbent surface, thoroughly mixed dry if sand be used, and a crater formed in the center, into which the proper percentage of clean water shall be poured; the material on the outer edge shall be turned into the center by the aid of a trowel. As soon as the water has been absorbed, the operation of mixing shall be completed by vigorously kneading with the hands for one minute.

Immediately after mixing, the paste or mortar shall be placed in the mold (Figs. 4 and 5, page 314) with the hands, pressed in firmly with the fingers, and smoothed off with a trowel without ramming. The material shall be heaped above the mold, and, in smoothing off, the trowel shall be drawn over the mold in such a manner as to exert a moderate pressure on the material; the mold shall then be turned over and the operation of heaping and smoothing off repeated.

The temperature of the room and of the mixing water shall be maintained as nearly as practicable at 21° C. (70° F.).

10. STORAGE OF THE TEST PIECES.

During the first 24 hr. after molding, the test pieces shall be stored in a moist closet. This consists of a box of soapstone or slate, or of wood lined with metal, the interior surface being covered with felt or broad wicking kept wet, the bottom of the box being kept covered with water. The interior of the box is provided with glass shelves on which to place the test pieces, the shelves being so arranged that they may be withdrawn readily.

Test pieces from any sample which vary more than 3 per cent in weight from the average, after removal from the moist closet, shall not be considered in determining strength.

After 24 hr. in the moist closet, the pieces to be tested after longer periods shall be immersed in water in storage tanks or pans made of non-corrodible material.

The air and water in the moist closet and the water in the storage tanks shall be maintained, as nearly as practicable, at 21° C. (70° F.).

11. TESTS OF TENSILE STRENGTH.

The tests may be made with any standard machine.

The clip is shown in Fig. 6, page 315. It must be made accurately, the pins and rollers turned, and the rollers bored slightly larger than the pins so as to turn easily. There should be a slight clearance at each end of the roller, and the pins should be kept properly lubricated and free from grit. The clips shall be used without cushioning at the points of contact.

The test pieces shall be broken as soon as they are removed from the water. The load shall be applied at the rate of 600 lb. per minute.

Test pieces which do not break within $\frac{1}{4}$ in. of the center, or are otherwise manifestly faulty, shall be excluded in determining average results.

12. TESTS OF COMPRESSIVE STRENGTH.

The tests may be made with any machine provided with means for so applying the load that the line of pressure is along the axis of the test piece. A ball-bearing block for this purpose is shown in Fig. 7, page 317.

The test pieces as soon as they are removed from the water shall be placed in the testing machine, with a piece of heavy blotting paper on each of the crushing faces, which should be those that were in contact with the mold.

13. CONSTANCY OF VOLUME.

Tests for constancy of volume comprise "normal tests" which are made in air or water, maintained as nearly as practicable, at 21° C. (70° F.), and the "accelerated test," which is made in steam. These tests shall be made in the following manner:

Pats about three inches in diameter, one-half inch thick at the center, and tapering to a thin edge, shall be made on clean glass plates (about four inches square) from cement paste of normal consistency, and stored in a moist closet for 24 hr.

Normal Tests.—After 24 hr. in the moist closet, a pat is immersed in water and observed at intervals. A similar pat, after 24 hr. in the moist closet, is exposed to the air for 28 days or more and observed at intervals. The air and water are maintained, as nearly as practicable, at 21° C. (70° F.).

Accelerated Test.—After 24 hr. in the moist closet, a pat is placed in an atmosphere of steam, upon a wire screen 1 in. above boiling water, for 5 hr. the apparatus being such that the steam will escape freely and atmospheric pressure be maintained. The apparatus is shown in Fig. 8, page 318.

The cement passes these tests when the pats remain firm and hard, with no signs of cracking, distortion, or disintegration.

APPENDIX.

METHODS FOR THE CHEMICAL ANALYSIS OF LIMESTONES, RAW MIXTURES AND PORTLAND CEMENTS.

RECOMMENDED BY THE COMMITTEE ON UNIFORMITY IN TECHNICAL ANALYSIS OF THE NEW YORK SECTION OF THE SOCIETY FOR CHEMICAL INDUSTRY.

Solution.—One-half gram of the finely-powdered substance is to be weighed out and, if a limestone or unburned mixture, strongly ignited in a covered platinum crucible over a strong blast for fifteen minutes, or longer if the blast is not powerful enough to effect complete conversion to a cement in this time. It is then transferred to an evaporating dish, preferably of platinum for the sake of celerity in evaporation, moistened with enough water to prevent lumping, and 5 to 10 c. c. of strong HCl added and digested with the aid of gentle heat and agitation until solution is complete. Solution may be aided by light pressure with the flattened end of a glass rod.* The solution is then evaporated to dryness, as far as this may be possible on the bath.

Silica (SiO_2).—The residue without further heating is treated at first with 5 to 10 c. c. of strong HCl, which is then diluted to half strength or less, or upon the residue may be poured at once a larger volume of acid of half strength. The dish is then covered and digestion allowed to go on for 10 minutes on the bath, after which the solution is filtered and the separated silica washed thoroughly with water. The filtrate is again evaporated to dryness, the residue without further heating, taken up with acid and water and the small amount of silica it contains separated on another filter paper. The papers containing the residue are transferred wet to a weighed platinum crucible, dried, ignited, first over a Bunsen burner until the carbon of the filter is completely consumed, and finally over the blast for 15 minutes and checked by a further blasting for 10 minutes or to constant weight. The silica, if great accuracy is desired, is treated in the crucible with about 10 c. c. of HFl and four drops of H_2SO_4 and evaporated over a low flame to complete dryness. The small residue is finally blasted, for a minute or two, cooled and weighed. The difference between this weight and the weight previously obtained gives the amount of silica.†

Alumina and Iron (Al_2O_3 *and* Fe_2O_3).—The filtrate, about 250 c. c., from the second evaporation for SiO_2, is made alkaline with NH_4OH after adding

*If anything remains undecomposed it should be separated, fused with a little Na_2CO_3, dissolved and added to the original solution. Of course a small amount of separated non-gelatinous silica is not to be mistaken for undecomposed matter.

†For ordinary control in the plant laboratory this correction may, perhaps, be neglected; the double evaporation never.

HCl, if need be, to insure a total of 10 to 15 c. c. strong acid, and boiled to expel excess of NH_3, or until there is but a faint odor of it, and the precipitate iron and aluminum hydrates, after settling, are washed once by decantation and slightly on the filter. Setting aside the filtrate, the precipitate is dissolved in hot dilute HCl, the solution passing into the beaker in which the precipitation was made. The aluminum and iron are then reprecipitated by NH_4OH, boiled and the second precipitate collected and washed on the same filter used in the first instance. The filter paper, with the precipitate, is then placed in a weighed platinum crucible, the paper burned off and the precipitate ignited and finally blasted 5 minutes, with care to prevent reduction, cooled and weighed as $Al_2O_3 + Fe_2O_3$.*

Iron (Fe_2O_3).—The combined iron and aluminum oxides are fused in a platinum crucible at a very low temperature with about 3 to 4 grams of $KHSO_4$, or, better, $NaHSO_4$, the melt taken up with so much dilute H_2SO_4 that there shall be no less than 5 grams absolute acid and enough water to effect solution on heating. The solution is then evaporated and eventually heated till acid fumes come off copiously. After cooling and redissolving in water the small amount of silica is filtered out, weighed and corrected by HFl and H_2SO_4.† The filtrate is reduced by zinc, or preferably by hydrogen sulphide, boiling out the excess of the latter afterwards while passing CO_2 through the flask, and titrated with permanganate.‡ The strength of the permanganate solution should not be greater than 0.0040 gr. Fe_2O_3 per c. c.

Lime (*CaO*).—To the combined filtrate from the $Al_2O_3 + Fe_2O_3$ precipitate a few drops of NH_4OH are added, and the solution brought to boiling. To the boiling solution 20 c. c. of a saturated solution of ammonium oxalate are added, and the boiling continued until the precipitated CaC_2O_4 assumes a well-defined granular form. It is then allowed to stand for 20 minutes, or until the precipitate has settled, and then filtered and washed. The precipitate and filter are placed wet in a platinum crucible, and the paper burned off over a small flame of a Bunsen burner. It is then ignited, redissolved in HCl, and the solution made up to 100 c. c. with water. Ammonia is added in slight excess, and the liquid is boiled. If a small amount of Al_2O_3 separates this is filtered out, weighed, and the amount added to that found in the first determination, when greater accuracy is desired. The lime is then reprecipitated by ammonium oxalate, allowed to stand until settled, filtered, and washed,§ weighed as oxide by ignition and blasting in a covered crucible to constant weight, or determined with dilute standard permanganate.‖

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*This precipitate contains TiO_2, P_2O_5, Mn_3O_4.

†This correction of Al_2O_3 Fe_2O_3 for silica should not be made when the HFl correction of the main silica has been omitted, unless that silica was obtained by only one evaporation and filtration. After two evaporations and filtrations 1 to 2 mg. of SiO are still to be found with the Al_2O_3 Fe_2 O_3.

‡In this way only is the influence of titanium to be avoided and a correct result obtained for iron.

§The volume of wash-water should not be too large; *vide* Hillebrand.

‖The accuracy of this method admits of criticism, but its convenience and rapidity demand its insertion.

Magnesia (MgO).—The combined filtrates from the calcium precipitates are acidified with HCl and concentrated on the steam bath to about 150 c. c., 10 c. c. of saturated solution of Na (NH_4) HPO_4 are added, and the solution boiled for several minutes. It is then removed from the flame and cooled by placing the beaker in ice water. After cooling, NH_4OH is added drop by drop with constant stirring until the crystalline ammonium-magnesium orthophosphate begins to form, and then in moderate excess, the stirring being continued for several minutes. It is then set aside for several hours in a cool atmosphere and filtered. The precipitate is redissolved in hot dilute HCl, the solution made up to about 100 c. c., 1 c. c. of a saturated solution of $Na(NH_4)HPO_4$ added, and ammonia drop by drop, with constant stirring until the precipitate is again formed as described and the ammonia is in moderate excess. It is then allowed to stand for about 2 hours, when it is filtered on a paper or a Gooch crucible, ignited, cooled and weighed as $Mg_2P_2O_7$.

Alkalies (K_2O and Na_2O).—For the determination of the alkalies, the well-known method of Prof. J. Lawrence Smith is to be followed, either with or without the addition of $CaCO_3$ with NH_4Cl.

Anhydrous Sulphuric Acid (SO_3).—One gram of the substance is dissolved in 15 c. c. of HCl, filtered and residue washed thoroughly.*

The solution is made up to 250 c. c. in a beaker and boiled. To the boiling solution 10 c. c. of a saturated solution of $BaCl_2$ is added slowly drop by drop from a pipette and the boiling continued until the precipitate is well formed, or digestion on the steam bath may be substituted for the boiling. It is then set aside over night, or for a few hours, filtered, ignited and weighed as $BaSO_4$.

Total Sulphur.—One gram of the material is weighed out in a large platinum crucible and fused with Na_2CO_3 and a little KNO_3, being careful to avoid contamination from sulphur in the gases from source of heat. This may be done by fitting the crucible in a hole in an asbestos board. The melt is treated in the crucible with boiling water and the liquid poured into a tall narrow beaker and more hot water added until the mass is disintegrated. The solution is then filtered. The filtrate contained in a No. 4 beaker is to be acidulated with HCl and made up to 250 c. c. with distilled water, boiled, the sulphur precipitated as $BaSO_4$ and allowed to stand over night or for a few hours.

Loss on Ignition.—Half a gram of cement is to be weighed out in a platinum crucible, placed in a hole in an asbestos board so that about three fifths of the crucible projects below, and blasted 15 minutes, preferably with an inclined flame. The loss by weight, which is checked by a second blasting of 5 minutes, is the loss on ignition.

May, 1903: Recent investigations have shown that large errors in results are often due to the use of impure distilled water and reagents. The analyst should, therefore, test his distilled water by evaporation and his reagents by appropriate tests before proceeding with his work.

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*Evaporation to dryness is unnecessary, unless gelatinous silica should have separated and should never be performed on a bath heated by gas; *vide* Hillebrand.

AMERICAN SOCIETY FOR TESTING MATERIALS

PHILADELPHIA, PA., U. S. A.

AFFILIATED WITH THE

INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.

STANDARD TEST FOR FIREPROOF FLOOR CONSTRUCTION.

ADOPTED AUGUST 15, 1908.

The test structure may be located at any place convenient to the applicant, where all the necessary facilities for properly conducting the test are provided.

The test structure may be constructed of walls of any material not less than twelve inches thick, properly buttressed on all sides.

The floor construction to be tested shall form the roof of the test structure.

At a height of not less than 2 ft. 6 ins., nor more than 3 ft. above the ground level, a metal grate, properly supported, shall be provided, covering the whole inside area of the building.

In the walls below this grate level, draught openings shall be provided, as many as possible, furnishing openings with an aggregate area of not less than one square foot for every ten square feet of grate surface. Means for temporarily closing these openings should be provided.

In the wall, immediately above the grate level, a firing door, 3 ft. 6 ins. by 5 ft. high, must be provided in the side of the building at right angles to the floor beams. A second door must be added when the span of the floor slab under test exceeds ten feet.

Flues should be supplied at each of the corners, and oftener in case of a test structure exceeding 250 sq. ft. of grate surface, with sufficient opening to insure a proper draught, securely supported and disposed at the sides of the structure in such

manner as not to rest on the floor under test. In no case should a flue area be less than 180 sq. ins.

The horizontal dimensions of the test structure will depend upon the number and the span of the systems under consideration. The clear span of the floor beams is to be 14 ft. The distance between floor beams, or span of slab, may be varied according to the design of the system to be tested, and should be as near as possible to usual practice. The underside of the construction under test must be not less than 9 ft. 6 ins. nor more than 10 ft. above the grate level.

The construction to be tested should be designed for a working load of 150 lbs. per sq. ft., and no more. This load is to be uniformly distributed without arching effect, and is to be carried on the floor during the fire test.

The floor may be tested as soon after construction as desired, but within forty days. Artificial drying will be allowed if desired.

No plastering shall be applied to the underside of the floor construction under test.

The floor shall be subjected for four hours to the continuous heat of a fire of an average temperature of not less than 1700° F.; the fuel used being either wood or gas, so introduced as to cause an even distribution of heat throughout the test structure.

The heat obtained shall be measured by means of standard pyrometers, under the direction of an experienced person. The type of pyrometer is immaterial so long as its accuracy is secured by proper standardization. The heat should be measured at not less than two points when the main floor span is not more than 10 ft. and one additional point when it exceeds 10 ft. Temperature readings at each point are to be taken every three minutes. The heat determination shall be made at points directly beneath the floor so as to secure a fair average.

At the end of the heat test a stream of water shall be directed against the underside of the floor, discharged through a $1\frac{1}{8}$-in. nozzle, under 60 lbs. nozzle pressure, for ten minutes, the nozzle being held not more than 3 ft. from the firing door during the application of the water.

After the floor has sufficiently cooled the load on the same

shall be increased to 600 lbs. per sq. ft., uniformly distributed.

The test shall not be regarded as successful unless the following conditions are met: No fire or smoke shall pass through the floor during the fire test; the floor must safely sustain the loads prescribed; the permanent deflection must not exceed one-eighth inch for each foot of span in either slab or beam.

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STANDARD TEST FOR FIREPROOF PARTITION CONSTRUCTION.

ADOPTED AUGUST 16, 1909.

The test structure may be located at any place convenient to the investigator, where all the necessary facilities for properly conducting the test are provided.

The test structure shall be of such design that the partition construction to be tested shall form at least one side of the structure. The other sides, roof, and foundations of the structure may be of any materials and design that will withstand and confine the fire within the test structure for the required time.

At a height of not less than 2 ft. 6 ins., nor more than 3 ft., above the ground level, a metal grate, properly supported, shall be provided, covering the whole inside area of the building.

In the walls below the grate level, draught openings shall be provided, as many as possible, furnishing openings with an aggregate area of not less than one square foot for every ten square feet of grate surface. Means for temporarily closing these openings shall be provided.

Immediately above the grate level, in one of the end walls of the structure, a firing door 3 ft. 6 ins. wide by 5 ft. high must be provided.

Flues shall be supplied at each of the corners, and more often for a test structure with more than 250 sq. ft. of grate surface, with sufficient opening to insure a proper draught. In no case shall a flue area be less than 180 sq. ins.

The size of the test structure will depend on the area of the

partition construction to be tested. In no case shall the partition construction under test be less than 9 ft. 6 ins. high, nor less than 14 ft. 6 ins. long. This entire area must be above the level of the grate bars, and, within such dimensions, must not be reinforced or braced in any manner other than is done as an inherent and essential part of the system of construction. The edges may be supported in any manner fairly representing the conditions of support in good practice.

The width of the test structure at right angles to the partition under test shall not be less than 9 ft.

The construction to be tested shall be subjected for two hours to the continuous heat of a fire, rising in temperature to 1700° F. by the end of the first half hour, and maintained at an average temperature of 1700° F. for the balance of the test; the fuel used being either wood, gas or oil, so introduced as to cause an even distribution of the heat throughout the test structure.

The temperature obtained shall be measured by means of standard pyrometers under the direction of an experienced person. The type of pyrometer is immaterial so long as its accuracy is secured by proper standardization. The temperature should be measured near the center of the test structure about 6 ins. below the roof or ceiling, and also at the center of each partition under test about 7 ft. above the grate level. In case the partition under test is more than 15 ft. long, additional pyrometers shall be used, symmetrically disposed and not more than 12 ft. apart. Temperature readings at each point shall be taken every three minutes, and the average used as the controlling temperature.

At the end of the heat test, a stream of water shall be directed against the construction under test, discharged through a $1\frac{1}{8}$-in. nozzle, under 30 lbs. nozzle pressure, for two and one-half minutes, the nozzle being held within 2 ft. of the firing door and the hose stream being played backward and forward over the entire surface of the partition under test.

The test shall not be regarded as successful unless the following conditions are met: No fire or smoke shall pass through the partition during the fire test; the partition must safely sustain the pressure of the hose stream; the partition must not warp or bulge, or disintegrate under the action of the fire or water to such an extent as to be unsafe.

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STANDARD ABRASION TEST FOR ROAD MATERIAL.

ADOPTED AUGUST 15, 1908.

This well-known test is similar in almost all respects to the Deval abrasion test of the French School of Roads and Bridges. It has been used since 1878, and is entirely satisfactory for the purpose for which it was designed.

ABRASION TEST.

The machine shall consist of one or more hollow iron cylinders; closed at one end and furnished with a tightly fitting iron cover at the other; the cylinders to be 20 cm. in diameter and 34 cm. in depth, inside. These cylinders are to be mounted on a shaft at an angle of 30° with the axis of rotation of the shaft.

At least 30 lbs. of coarsely broken stone shall be available for a test. The rock to be tested shall be broken in pieces as nearly uniform in size as possible, and as nearly 50 pieces as possible shall constitute a test sample. The total weight of rock in a test shall be within 10 grams of 5 kilograms. All test pieces shall be washed and thoroughly dried before weighing. Ten thousand revolutions, at the rate of between 30 and 33 to the minute, shall constitute a test. Only the percentage of material worn off which will pass through a 0.16 cm. (1-16 in.) mesh sieve shall be considered

in determining the amount of wear. This may be expressed either as the percentage of the 5 kilograms used in the test, or the French coefficient, which is in more general use, may be given; that is, coefficient of wear $= 20 \times \frac{20}{w} = \frac{400}{w}$, where w is the weight in grams of the detritus under 0.16 cm. (1-16 in.) in size per kilogram of rock used.

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STANDARD TOUGHNESS TEST FOR MACADAM ROCK.

ADOPTED AUGUST 15, 1908.

In the consideration of macadam road materials, toughness is understood to mean the power possessed by a material to resist fracture by impact.

In testing macadam rocks under impact, it has been found best to apply a number of blows of successively increasing energy and note the blow causing failure. The following test involving this principle is, therefore, recommended for determining the toughness of rock for macadam road building.

TOUGHNESS TEST.

1. Test pieces may be either cylinders or cubes, 25 mm. in diameter, and 25 mm. in height, cut perpendicular to the cleavage of the rock. Cylinders are recommended as they are cheaper and more easily made.

2. The testing machine shall consist of an anvil of 50 kilograms weight, and placed on a concrete foundation. The hammer shall be of 2 kilograms weight, and dropped upon an intervening plunger of 1 kilogram weight, which rests on the test piece. The lower or bearing surface of this plunger shall be of spherical shape having a radius of 1 cm. This plunger shall be made of hardened steel, and pressed firmly upon the test piece

by suitable springs. The test piece shall be adjusted, so that the center of its upper surface is tangent to the spherical end of the plunger.

3. The test shall consist of a 1-cm. fall of the hammer for the first blow, and an increased fall of 1 cm. for each succeeding blow until failure of the test piece occurs. The number of blows necessary to destroy the test piece is used to represent the toughness, or the centimeter-grams of energy applied may be used.

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PROVISIONAL METHOD FOR THE DETERMINATION OF SOLUBLE BITUMEN.*

ADOPTED AUGUST 21, 1911.

Drying the Sample and Preparing it for Analysis.—It was decided, owing to the great variety of conditions met with in bituminous compounds, that it is impossible to specify any one method of drying that would be satisfactory in every case. It is therefore supposed that the material for analysis has been previously dried either in the laboratory or in the process of refining or manufacture, and that water, if present, exists only as moisture in the hydroscopic form.

The material to be analyzed, if hard and brittle, is ground and spread in a thin layer in a suitable dish (iron or nickel will answer every purpose) and kept at a temperature of 125° C. for one hour. In the case of paving mixtures and road materials, where it is not desirable to crush the rock or sand grains, a lump may be placed in the drying oven until it is thoroughly heated through, when it can be crushed down into a thin layer and dried as above. If the material under examination contains any hydrocarbons at all volatile at this temperature, it will of course be

* The Committee, in presenting the Provisional Method for the Determination of Soluble Bitumen, wish it understood that they do not recommend it as the best for general use, as it is longer and in many cases gives no better results than other more expeditious methods, but only as a method to be resorted to in case of dispute, as it seems to have the widest range of applicability of any of the methods considered. Moreover, they wish it to be understood that with some classes of materials the method will show a lower percentage of soluble bitumen than many of the shorter methods.

necessary to resort to other means of drying. Tar or oils may be dehydrated by distillation and the water-free distillate returned to the residue and thoroughly incorporated with it.

Analysis of Sample.—After drying, from 2 to 15 grams (as may be necessary to insure the presence of 1 to 2 grams of pure bitumen) is weighed into a 150-cc. tared Erlenmeyer flask, and treated with 100 cc. of carbon disulphide. The flask is then loosely corked and shaken from time to time until all large particles of the material have been broken up. It is then set aside for 48 hours to settle. The solution is decanted into a similar flask that has been previously weighed. As much of the solvent is poured off as possible without disturbing the residue. The contents of the first flask are again treated with fresh carbon disulphide, shaken as before, and then put away with the second flask for 48 hours to settle.

The liquid in the second flask is then carefully decanted upon a weighed Gooch crucible, 3.2 cm. in diameter at the bottom, fitted with an asbestos filter, and the contents of the first flask are similarly treated. The asbestos filter is made of ignited long-fiber amphibole, packed in the bottom of a Gooch crucible to the depth of not over $\frac{1}{8}$ in. In filtering no vacuum is to be used and the temperature is to be kept between 20° and 25° C. After passing the liquid contents of both flasks through the filter, the residue on the filter is thoroughly washed and the residues remaining in them are shaken with more fresh carbon disulphide and allowed to settle for 24 hours, or until it is seen that a good subsidation has taken place. The solvent in both flasks is then again decanted through the filter and the residues remaining in them are washed until the washings are practically colorless. All washings are to be passed through the Gooch crucible.

The crucible and both flasks are then dried at 125° C. and weighed. The filtrate containing the bitumen is evaporated, the bituminous residue burned, and the weight of the ash thus obtained added to that of the residue in the two flasks and the crucible. The sum of these weights deducted from the weight of substance taken gives the weight of soluble bitumen.

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PROVISIONAL METHOD FOR THE DETERMINATION OF THE PENETRATION OF BITUMEN.

ADOPTED AUGUST 21, 1911.

The penetration of bitumen shall be the distance expressed in hundredths of a centimeter that a No. 2 needle will pentrate into it vertically without friction at 25° C. under a stated weight applied for a stated length of time, the factors of weight and time being determined as follows:

The material shall first be tested for five seconds under a weight of 100 grams. If this result is less than 10, the penetration shall be determined under a weight of 200 grams applied for one minute; if between 10 and 300, the penetration shall be determined under a weight of 100 grams applied for 5 seconds; if greater than 300, the penetration shall be determined under a weight of 50 grams applied for 5 seconds. In every case the factor of weight and time shall be stated when reporting the penetration, and whenever possible to obtain both readings, the penetration under a 100-gram weight for 5 seconds and under the modified weight and time shall both be reported. When testing material softer than 100 penetration, a containing receptacle not less than $1\frac{1}{4}$ ins. in diameter shall be used.

It is recommended that the penetration may be determined at 0° C. (32° F.) and 46° C. (114°.8 F.), in addition to the 25° C (77° F.) test.

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PROVISIONAL METHOD FOR THE DETERMINATION OF THE LOSS ON HEATING OF OIL AND ASPHALTIC COMPOUNDS.

ADOPTED AUGUST 21, 1911.

The loss on heating of oil and asphaltic compounds shall be determined in the following manner: Twenty grams of the water-free material shall be placed in a circular tin box with vertical sides, measuring about 2 cm. in depth by 6 cm. in diameter, internal measurement. The penetration of the material to be examined shall, if possible, be determined at 25° C. and the exact weight of the sample ascertained. The sample in the tin box shall then be placed in a hot-air oven (New York Testing Laboratory oven without fan), heated to 163° C. (325° F.) and kept at this temperature for 5 hours. At no time shall the temperature of this oven vary more than 2° C. from 163° C. When the sample is cooled to normal temperature, it shall be weighed and the percentage of loss by volatilization reported. The penetration of the residue shall then, if possible, be determined at 25° C. as upon the original material, and the loss in penetration found by subtracting this penetration from the penetration before heating. In preparing the residue for the penetration test it shall first be heated and thoroughly stirred while cooling.

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PROVISIONAL METHOD OF SIZING AND SEPARATING THE AGGREGATE IN ASPHALT PAVING MIXTURES.

ADOPTED AUGUST 21, 1911.

The method consists of passing the mineral aggregate through several sieves of the following sizes in the order named:

Meshes per linear inch (=2.54 cm.)	Diameter of Wire. Ins.	Mm.
200	0.00235	0.05969
100	0.0045	0.1143
80	0.00575	0.1460
50	0.009	0.22865
40	0.01025	0.26035
30	0.01375	0.34925
20	0.0165	0.4191
10	0.027	0.6858

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INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.

STANDARD CLASSIFICATION OF STRUCTURAL TIMBER.

ADOPTED SEPTEMBER 1, 1907.

I. DEFINITION OF STRUCTURAL TIMBER.

By the term "Structural Timber" the Committee understands all such products of wood in which the strength of the timber is the controlling element in their selection and use. The following is a list of products which are recommended for consideration as structural timbers:

Trestle Timbers.—Stringers, caps, posts, mud sills, bracing, bridge ties, guard rails.

Car Timbers.—Car framing, including upper framing; car sills.

Framing for Buildings.—Posts, mud sills, girders, framing, joists.

Ship Timbers.—Ship timbers, ship decking.

Cross Arms for Poles.

II. STANDARD DEFECTS.

Measurements which refer to the diameter of knots or holes should be considered as referring to the mean or average diameter.

1. *Sound Knot.*—A sound knot is one which is solid across its face and which is as hard as the wood surrounding it; it may be either red or black, and is so fixed by growth or position that it will retain its place in the piece.

2. *Loose Knot.*—A loose knot is one not firmly held in place by growth or position.

3. *Pith Knot.*—A pith knot is a sound knot with a pith hole not more than $\frac{1}{4}$ in. in diameter in the center.

4. *Encased Knot.*—An encased knot is one which is surrounded wholly or in part by bark or pitch. Where the encasement is less than $\frac{1}{8}$ in. in width on both sides, not exceeding one-half the circumference of the knot, it shall be considered a sound knot.

5. *Rotten Knot.*—A rotten knot is one not as hard as the wood it is in.

6. *Pin Knot.*—A pin knot is a sound knot not over $\frac{1}{2}$ in. in diameter.

7. *Standard Knot.*—A standard knot is a sound knot not over $1\frac{1}{2}$ ins. in diameter.

8. *Large Knot.*—A large knot is a sound knot, more than $1\frac{1}{2}$ ins. in diameter.

9. *Round Knot.*—A round knot is one which is oval or circular in form.

10. *Spike Knot.*—A spike knot is one sawn in a lengthwise direction; the mean or average width shall be considered in measuring these knots.

11. *Pitch Pockets.*—Pitch pockets are openings between the grain of the wood containing more or less pitch or bark. These shall be classified as *small*, *standard* and *large* pitch pockets.

(*a*) *Small Pitch Pocket.* A small pitch pocket is one not over $\frac{1}{8}$ in. wide.

(*b*) *Standard Pitch Pocket.* A standard pitch pocket is one not over $\frac{3}{8}$ in. wide, or 3 ins. in length.

(*c*) *Large Pitch Pocket.* A large pitch pocket is one over $\frac{3}{8}$ in. wide, or over 3 ins. in length.

12. *Pitch Streak.*—A pitch streak is a well-defined accumulation of pitch at one point in the piece. When not sufficient to develop a well-defined streak, or where the fiber between grains,

PLATE I.
PROC. AM. SOC. TEST. MATS.
STANDARD CLASSIFICATION OF STRUCTURAL TIMBER.

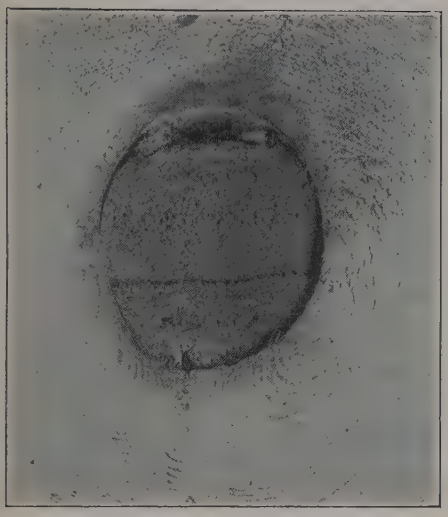

FIG. 1.—Loose Knot.

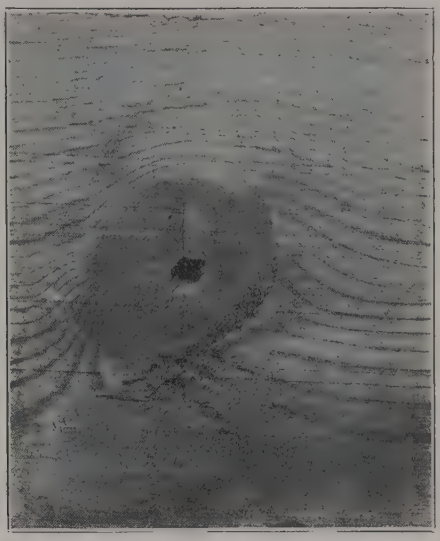

FIG. 2.—Pith Knot.

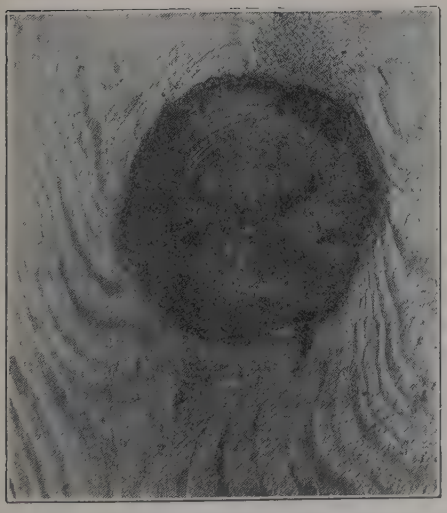

FIG. 3.—Encased Knot.

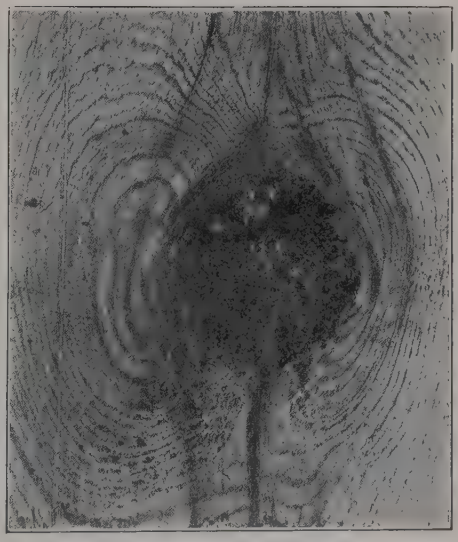

FIG. 4.—Rotten Knot.

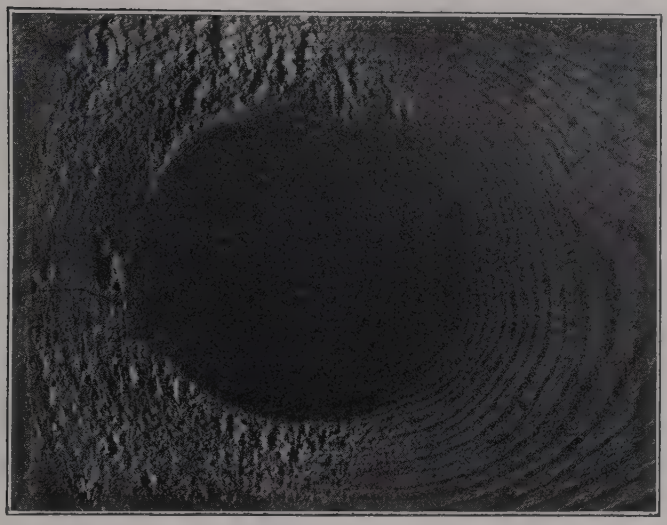

FIG. 6.—Standard Knot.

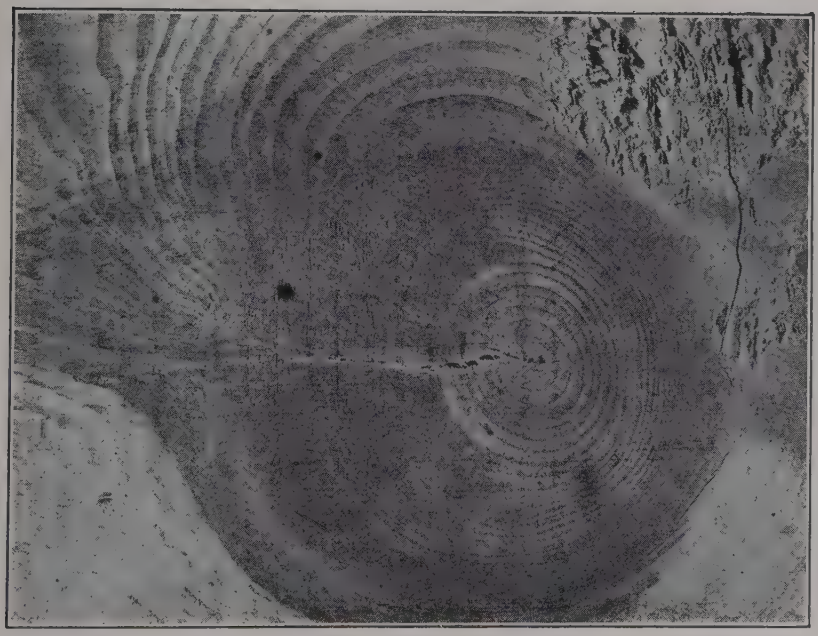

FIG. 7.—Large Knot.

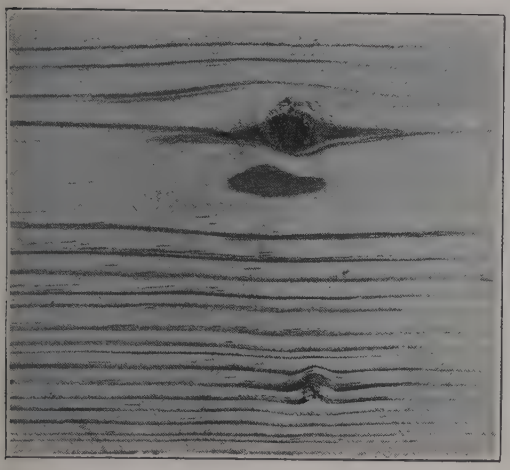

FIG. 5.—Pin Knot.

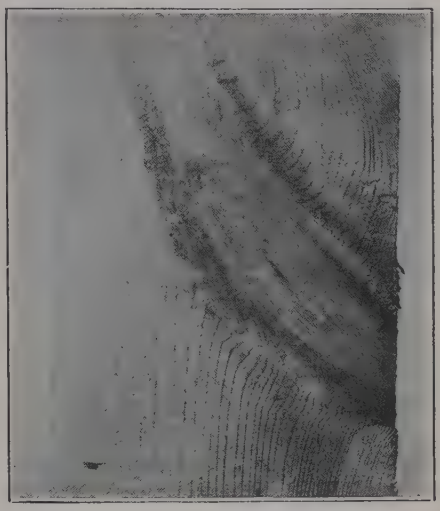

FIG. 8.—Spike Knot.

FIG. 9.—Pitch Pocket.

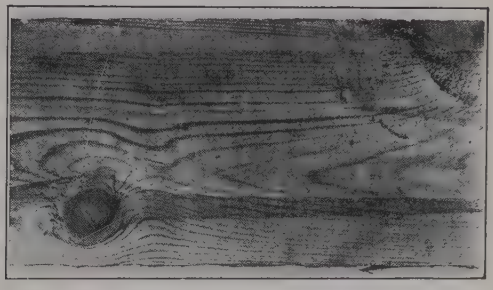

FIG. 10.—Pitch Streak.

that is, the coarse-grained fiber, usually termed "Spring wood," is not saturated with pitch, it shall not be considered a defect.

13. *Wane.*—Wane is bark, or the lack of wood from any cause, on edges of timbers.

14. *Shakes.*—Shakes are splits or checks in timbers which usually cause a separation of the wood between annual rings.

15. *Rot, Dote* and *Red Heart.*—Any form of decay which may be evident either as a dark red discoloration not found in the sound wood, or the presence of white or red rotten spots, shall be considered as a defect.

16. *Ring Shake.*—An opening between the annual rings.

17. *Through Shake.*—A shake which extends between two faces of a timber.

III. STANDARD NAMES FOR STRUCTURAL TIMBERS.

1. *Southern Yellow Pine.*—Under this heading two classes of timber are used, (*a*) Longleaf Pine, (*b*) Shortleaf Pine.

It is understood that these two terms are descriptive of quality, rather than of botanical species. Thus, shortleaf pine would cover such species as are now known as North Carolina pine, loblolly pine, and shortleaf pine. "Longleaf Pine" is descriptive of quality, and if Cuban, shortleaf, or loblolly pine is grown under such conditions that it produces a large percentage of hard summer wood, so as to be equivalent to the wood produced by the true longleaf, it would be covered by the term "Longleaf Pine."

2. *Douglas Fir.*—The term "Douglas Fir" is to cover the timber known likewise as yellow fir, red fir, western fir, Washington fir, Oregon or Puget Sound fir or pine, norwest and west coast fir.

3. *Norway Pine,* to cover what is known also as "Red Pine."

4. *Hemlock,* to cover Southern or Eastern hemlock; that is, hemlock from all States east of and including Minnesota.

5. *Western Hemlock,* to cover hemlock from the Pacific coast.

6. *Spruce,* to cover Eastern spruce; that is, the spruce timber coming from points east of Minnesota.

7. *Western Spruce*, to cover the spruce timber from the Pacific coast.

8. *White Pine*, to cover the timber which has hitherto been known as white pine, from Maine, Michigan, Wisconsin and Minnesota.

9. *Idaho White Pine*, the variety of white pine from western Montana, northern Idaho, and eastern Washington.

10. *Western Pine*, to cover the timber sold as white pine coming from Arizona, California, New Mexico, Colorado, Oregon and Washington. This is the timber sometimes known as "Western Yellow Pine," or "Ponderosa Pine," or "California White Pine," or "Western White Pine."

11. *Western Larch*, to cover the species of larch or tamarack from the Rocky Mountain and Pacific coast regions.

12. *Tamarack*, to cover the timber known as "Tamarack," or "Eastern Tamarack," from States east of and including Minnesota.

13. *Redwood*, to include the California wood usually known by that name.

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INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.

STANDARD SPECIFICATIONS FOR YELLOW-PINE BRIDGE AND TRESTLE TIMBERS.

ADOPTED SEPTEMBER 1, 1910.

(To be applied to single sticks and not to composite members.)

GENERAL REQUIREMENTS.

Except as noted, all timber shall be sound, sawed to standard size, square-edged and straight; shall be close-grained and free from defects, such as injurious ring shakes and cross grain, unsound or loose knots, knots in groups, decay, or other defects that will materially impair its strength.

Standard Size of Sawed Timber.—Rough timbers sawed to standard size shall mean that they shall not be over $\frac{1}{4}$ in. scant from the actual size specified. For instance, a 12 by 12-in. timber shall measure not less than $11\frac{3}{4}$ by $11\frac{3}{4}$ ins.

Standard Dressing of Sawed Timber.—Standard dressing shall mean that not more than $\frac{1}{4}$ in. shall be allowed for dressing each surface. For instance, a 12 by 12-in. timber after being dressed on four sides shall measure not less than $11\frac{1}{2}$ by $11\frac{1}{2}$ ins.

STRINGERS.

Standard Heart Grade. Longleaf Yellow Pine.—Shall show not less than 85 per cent. heart on the girth anywhere in the length of the piece; provided, however, that if the maximum amount of

sap is shown on either narrow face of the stringer, the average depth of sap shall not exceed $\frac{1}{2}$ in. Knots greater than $1\frac{1}{2}$ ins. in diameter shall not be permitted at any section within 4 ins. of the edge of the piece; but knots shall in no case exceed 4 ins. in their largest diameter.

Standard Grade. Longleaf and Shortleaf Yellow Pine.—Shall be square-cornered, with the exception of 1 in. wane on one corner. Knots shall not exceed in their largest diameter one-fourth the width of the face of the stick in which they occur, and shall in no case exceed 4 ins. Ring shakes shall not extend over one-eighth of the length of the piece.

CAPS AND SILLS.

Standard Heart Grade. Longleaf Yellow Pine.—Shall show not less than 85 per cent. heart on each of the four sides, measured across the sides anywhere in the length of the piece, and shal be free from knots over $2\frac{1}{2}$ ins. in diameter.

Standard Grade. Longleaf and Shortleaf Yellow Pine.—Shall be square-cornered, with the exception of 1 in. wane on one corner, or $\frac{1}{2}$ in. wane on two corners. Knots shall not exceed in their largest diameter one-fourth the width of the face of the stick in which they occur, and shall in no case exceed 4 ins. Ring shakes shall not extend over one-eighth of the length of the piece.

POSTS.

Standard Heart Grade. Longleaf Yellow Pine.—Shall show not less than 75 per cent. heart on each of the four faces, measured across the sides anywhere in the length of the piece, and shall be free from knots over $2\frac{1}{2}$ ins. in diameter.

Standard Grade. Longleaf and Shortleaf Yellow Pine.—Shall be square-cornered, with the exception of 1 in. wane on one corner, or $\frac{1}{2}$ in. wane on two corners. Knots must not exceed in their largest diameter one-fourth the width of the face of the stick in which they occur, and shall in no case exceed 4 ins. Ring shakes shall not extend over one-eighth of the length of the piece.

LONGITUDINAL STRUTS AND GIRTS.

Standard Heart Grade. Longleaf Yellow Pine.—One side shall show all heart, and the other side shall show not less than

85 per cent. heart, measured across the side anywhere in the length of the piece; shall be free from any large knots or other defects that will materially injure its strength.

Standard Grade. Longleaf and Shortleaf Yellow Pine.—Shall be square-edged and sound, and shall be free from any large knots or other defects that will materially injure its strength.

LONGITUDINAL X-BRACES, SASH BRACES AND SWAY BRACES.

Standard Heart Grade. Longleaf Yellow Pine.—Shall show four square corners and not less than 80 per cent. heart on each of two faces, and shall be free from any large knots or other defects that will materially injure its strength.

Standard Grade. Longleaf and Shortleaf Yellow Pine.—Shall be square-cornered and sound, and shall be free from any large knots or other defects that will materially injure its strength.

TIES AND GUARD RAILS.

Standard Heart Grade. Longleaf Yellow Pine.—Shall show one side all heart; the other side and two edges shall show not less than 75 per cent. heart, measured across the face anywhere in the length of the piece. Shall be free from any large knots or other defects that will materially injure its strength. Where surfaced, the remaining rough face shall show all heart.

AMERICAN SOCIETY FOR TESTING MATERIALS

PHILADELPHIA, PA., U. S. A.

AFFILIATED WITH THE

INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.

STANDARD METHODS OF TESTING.

ADOPTED AUGUST 21, 1911.

I. METHODS FOR TENSILE TESTS OF METALS.

1. Information obtained from the various laboratories in which tensile tests are made shows that in many cases the forms and dimensions of specimens as recommended by the American Society for Testing Materials are in use, and that in other cases these forms and dimensions most nearly reconcile the differences that exist between the various forms employed.

2. It is therefore recommended that the selection of specimens, and their forms and dimensions, shall conform to the specifications for each material, as are now adopted by the American Society for Testing Materials.

3. It is believed that the distance between the end of gauge length and beginning of shoulders, as prescribed in the standard specifications of the American Society for Testing Materials, is ample to avoid interference with proper elongation, and no grounds are found for recommending any change.

4. All information obtained confirms the investigations of Committee O (since dissolved), to the effect that within the limits of speed common in commercial testing, the effect of different speeds on results is not of observable moment; that is, within ranges of speed varying from 1 to 6 ins. per minute.

5. Beyond these limits, however, very rapid loading influences the ultimate strength, which increases with the speed. Whether the elongation is increased or decreased depends somewhat upon

the nature of the material, though in general very rapidly applied loads will increase the stretch, owing to the elongation occurring over the whole body of the specimen, rather than chiefly at the point of reduction, which is more marked with slowly applied loads.

6. Within the limits of speed customary in determining the modulus of elasticity, it does not appear that the rate of loading influences the value obtained, but whether this value be determined by an autographic attachment to the machine, or by an extensometer on the specimen, it is desirable that the loading be not too rapid, or not over 0.05 in. per minute, to avoid impairing the accuracy of the sensitive devices employed.

7. In determining the modulus of elasticity, the elastic limit (the load at which stress and strain are no longer proportional), and the least load producing a given permanent set, it is considered necessary that the extensometer be attached to two sides of the specimen, to compensate for unequal elongation, for improper holding, or for any slight bending that may exist in the specimen.

8. All authorities seem to regard it as desirable to take the stretch on the two sides of the test piece, and most extensometers provide for so doing.

9. The greatest accuracy is required in determining the modulus of elasticity, since small errors in measuring elongation are of considerable consequence in the result.

10. Since the modulus is determined for points well within the elastic limit, the total elongation to be measured is much smaller than at the elastic limit.

11. The elastic limit should be determined with great care, but any inaccuracy will cause less proportionate error than in the case of the modulus. The yield point, being less well defined, cannot be so closely determined, and it is believed that in most cases the use of dividers instead of an extensometer will give sufficiently accurate results.

12. It is considered undesirable in accurate determinations of the modulus of elasticity to use a shorter gauge length than 8 ins. It is evident that the greater the total elongation measured, the less will be the error due to inaccuracy of the reading, and the accuracy thus appears to increase directly as the gauge length.

13. That the difference between short and long gauge lengths, has a greater influence in affecting results than other factors (personal error, inaccuracy of the testing machine, etc.), is shown by the closely agreeing readings obtained with the greater lengths.

14. The effect of improper methods of holding specimens could not be established from the results of actual tests. The result of improper methods of gripping materials of low stretch, such as cast iron, is well known, and it is probable that in material of a softer nature, the effect is largely local and does not extend to the portion of the specimen within the gauge marks.

Conditions to Ensure Correct Testing Machines.—1. It is recommended that in machines on which specimen tests are made, whether the power be applied hydraulically or by means of screws and gears, the load be measured by a separate system of levers and knife edges, or by a method similar to that employed in the Emery testing machines at the Watertown Arsenal.

2. All knife edges shall be kept sharp, and free from oil and dirt, and the machine shall be sensitive to a variation in load of one two-hundred-and-fiftieth of the load carried. Design and workmanship on testing machines shall be good, and they shall be calibrated at least once every six months by the following method:

Calibration of Testing Machines.—1. Test for accuracy by loading the weighing table with standard weights, and compare the actual weight at each addition with the reading of the beam. If the table is uniformly loaded in this manner with the full amount of weights that it will accommodate, the proportionality of the levers and the weighing beam can be successfully established. This relation, in a properly designed machine, will remain constant for all loads, but as a further test for sensitiveness under greater loads than can be accommodated in this manner, the following procedure is recommended:

2. Place in the machine a tension bar of such cross section that the maximum capacity will not stress it to the elastic limit. Stress this bar to various extents through the full range of the machine, and at each load balance the beam and place upon the weighing table standard weights of 100 lbs. A weight one two-hundred-and-fiftieth of the total load on the machine should produce a readable movement of the beam.

3. Where evidence of the accuracy of the machine over its

whole range is desired, a known load may be applied by means of an extensometer and calibrated bar, whose modulus of elasticity has been determined with exactness.

4. It is recommended that a device be adopted conforming to the following requirements, in which the extensometer and bar are permanently attached to each other:

(*a*) The bar shall be of high elastic limit material, and of such cross section that this limit will be well above the total capacity of the machine on which it is to be used.

(*b*) This bar shall be annealed or otherwise treated so as to eliminate internal or unequal stress in the material, and to ensure its elastic modulus being uniform for successive tests.

(*c*) The extensometer shall be permanently attached to the bar, and shall measure the elongation on two opposite sides.

(*d*) The extensometer shall be preferably of the indicating or direct-reading type, and shall indicate to ten-thousandths of an inch or less.

(*e*) The method of securing the bar in the drawheads of the machine shall be positive and without slip, and shall ensure its axial location.

(*f*) The length of the bar measured by the extensometer shall be sufficient, that the smallest extensometer division will correspond to a difference in loading of 100 lbs. or less.

(*g*) The extensometer shall be protected from injury by a permanently attached case with cover removable for reading the scale.

(*h*) The apparatus shall be plainly marked with the maximum load that can be safely applied without injury.

(*i*) The apparatus shall itself be calibrated either by the United States Bureau of Standards, or in a manner that will ensure equally trustworthy results.

Methods of Gripping Test Specimens.—1. It is recommended that for specimens of rolled material, serrated grips, flat and

V-shaped, be adopted, the former for rectangular and the latter for round specimens. Serrated grips with curved faces appear to have no advantage, and to cause crushing of the material.

2. Wedges with ball and socket do not seem to be necessary, and for commercial testing their use has been generally discontinued.

3. Specimens of turned form, with threaded ends, should be secured in such a manner that side bending stresses are avoided.

4. It is considered important for correct results that the specimen be located in the exact center of the heads, and to better secure this condition, the openings in the heads should be lined up with each other by means of a plumb-bob and be tested for parallelism with a spirit level. Each pair of packing pieces and wedges that are to be used together in the same head should correspond exactly in thickness and other dimensions, and the wedges should be inserted an equal distance when the specimen is in place.

Selection and Preparation of Specimen.—1. Specimens representative of steel castings may be cut from the bottom of a sink head or riser, or from a coupon attached to the casting. In either case the part from which the specimen is taken should be relatively large in proportion to the size of the casting and should be annealed with it.

2. Workmanship on specimens shall be of the most careful nature, and surfaces should be free from nicks and tool marks. All wire edges should be removed and corners generously rounded.

3. If specimens of rolled material are sheared in the rough from sections, at least $\frac{1}{8}$ in. of the material should be removed from the sheared edges in machining.

General Requirements for the Measuring of Elongation.—In determining the modulus of elasticity and the elastic limit, it is recommended that when practicable the elongation be measured in a length not less than 8 ins., and that the following requirements be provided for:

(*a*) The specimen shall be round in section, finished as smooth as possible, and shall be provided with threaded ends for attachment to the draw-heads of the machine.

(*b*) The specimen shall be placed in the exact center of the heads, and be secured in some positive manner, so that slip and side bending stresses do not occur.

(*c*) The extensometer should be of a type to measure the elongation on opposite sides of the specimen, and when adjusted the points of attachment should be exactly opposite each other.

(*d*) It should read to ten-thousandths of an inch or less.

(*e*) It should be of such a design that no change of zero will occur upon release of the load in determining the real elastic limit.

(*f*) The load shall be applied so slowly that simultaneous readings of elongation and load can be obtained with certainty.

(*g*) The testing machine shall have previously been calibrated for accuracy and sensitiveness, and heads lined up and made parallel.

II. METHODS FOR COMPRESSIVE TESTS OF METALS.

1. The test specimen shall be a cylinder having plane ends truly normal to its axis.

Only two replies from testing laboratories mention cubes. A cylindrical specimen will usually be cheaper to prepare than a cube. The stresses are probably less uniformly distributed over a square than over a circular section, owing to the influence of the corners, this being especially the case with the internal shearing stresses which accompany the compression.

2. The diameter of the specimen shall be not less than 1 in. nor greater than 1.13 ins. A specimen 1 in. in diameter is to be preferred.

The range of diameter mentioned in the replies from testing laboratories is from 1 in. to 1.129 ins. A diameter of 1.1284 ins. gives a section area of 1 sq. in.

3. The length of the specimen should be between 2.5 and 4 diameters.

Two testing laboratories use a length of 1 diameter, one a length of from 1.5 to 2 diameters, one a length of 2.6 diameters, and one a length of 10.5 diameters. It is believed that a length less than 2.5 diameters is

not sufficient for the internal shear to be properly developed, and that such short lengths give a fictitious strength owing to the friction of the bearing plates of the machine, which causes the specimen to assume a barrel-like form.

4. No bedding should be used for the ends of the specimen.

Only one reply favors bedding. It is known by general experience that bedding modifies the breaking load and that different kinds of bedding have different influences.

5. The bearing blocks which transmit the pressure from the testing machine should be truly normal to the plane ends of the specimen. To secure this, one of the blocks should be provided with a hemispherical bearing which can turn freely.

These requirements seem essential in order that the load may not be eccentrically applied to the specimen, and are generally recommended in the replies from testing laboratories.

6. The speed of compression should be slow, not exceeding 0.1 in. per minute. Near the elastic limit and yield point the load should be increased very slowly.

A lower speed than that stated might be advisable if permitted by the testing machine. Evidently a higher speed may be allowed with a long specimen than with a short one.

7. For determining modulus of elasticity, the linear compression of the specimen should be observed by a precise compressometer which is attached to the specimen and does not touch the bearing blocks of the machine. Readings of the compressometer should be taken for three loads, the first at about one fourth, the second at about one half, and the third at about three fourths of the elastic limit.

It is believed that these measurements are sufficient for most commercial work. Nothing is said about the release of the specimen from load, since opinions differ as to its advisability.

8. To determine the elastic limit, several readings of the compressometer should be taken as that limit is approached for load increments of 1,000 lbs. per sq. in.

This requirement seems sufficient to determine the proportional elastic limit for materials in which such a limit exists. It does not seem wise to require the first permanent set to be observed for ordinary commercial work.

9. The yield point is to be noted as corresponding to that load for which the compressometer shows a linear compression without an increase in load. In the absence of a compressometer this point may be noted, for ductile materials, by the drop of the scale beam.

This requirement corresponds to the usual practice of testing laboratories. It is regarded as important that the term "elastic limit" should not be used to designate the yield point.

10. Measurements for the modulus of elasticity, elastic limit, and yield point may be made, if desired, on a specimen ranging in length from 10 to 15 diameters.

This clause is inserted because it may often be difficult to apply a compressometer in a length shorter than 4 ins.

11. The record of the test should mention any phenomena observed near the elastic limit and yield point. The manner of final failure should also be noted when the test is carried to this limit.

This requirement furnishes data for comparing the behavior of brittle and ductile metals near critical points of molecular change.

III. METHODS FOR TRANSVERSE TESTS OF METALS.

1. In the case of cast metals, when transverse tests are to be used to aid in determining the quality of the material, the specimen used shall be cast vertical, shall be $1\frac{1}{4}$ ins. in diameter, and long enough to use a span of at least 15 times the diameter.

It is important that a definite and uniform standard be adopted so that the results may be comparable with each other; hence the diameter specified above (sectional area corresponding to practically one square inch). The determination of span is at present the subject of international tests to decide upon a definite distance to replace the present standard of 12 ins. It will probably be 16 to 18 ins.

The circular section will best secure a uniform thickness of skin, and thus avoid this irregularity when other sections are employed.

In the case of ductile materials (except in impact tests) transverse tests shall never be used to determine the quality of the material, tensile tests being those suitable for the purpose.

In small round or square bars of ductile material, both the modulus of rupture and the transverse elastic limit vary considerably with the span.

In the case of tests made for determining constants to be used for designing, the specimen shall conform as nearly as possible with the form and size of the piece to be used. Thus, if I or T sections are to be used, the specimens shall be of I or T section. In the case of flat springs or plate glass, they shall be flat; in the case of timber, rectangular; etc.

It is well known that the modulus of rupture varies with the shape of the section, being very much greater in the case of round than in I sections. Hence the modulus of rupture suitable for use for one would be entirely unsuitable for the other.

In rolled sections, the smaller ones are subjected to a more thorough working in the process of rolling than the larger.

2. In the case of the "Arbitration Bar" adopted for cast iron, the span has been fixed at 12 ins., but may be extended as above stated. The bar will serve for cast and brittle materials.

In the case of ductile materials, when the modulus of rupture is desired, the span shall generally be less than 12 or 15 times the depth. Exceptions, however, occur, as in flat springs and in some cases in full-size pieces, when the spans and methods of supporting the ends, etc., shall conform to the conditions of service.

3. In the case of cast and brittle metals, the speed of testing shall not exceed 0.2 in. per minute. For other specimens the speed shall be correspondingly low.

4. The preparation of the specimen shall be such that it truly represents the material itself. The introduction of extraneous influences should be avoided as far as the knowledge of the material will permit. Thus, in cast metals no coupons shall be used; cast materials for tests shall go into dry molds standing vertical.

No specimen shall be machined before testing, except when information is specifically desired regarding the strength of such machined specimens.

5. The transverse yield point for ductile materials shall be noted approximately by the drop of the scale beam.

6. If the transverse elastic limit is to be determined for comparison with that obtained in the tensile test, the successive increments of load in the neighborhood of the transverse elastic limit shall be comparatively small, and after each load has been applied and the corresponding deflection measured by means of the deflectometer, the load shall be removed and the deflection measured again to determine the permanent set.

In those cases where the arbitration bar is used for such cast materials as have an elastic limit, the increment of load used near the transverse elastic limit shall be 250 lbs.

It is well known that when the transverse elastic limit is determined, of course by means of a transverse test, the extreme fiber stress at this transverse elastic limit is not the same as that at the tensile elastic limit of the material; and moreover, that it varies with both the section and the span; hence the desirability of comparing the transverse elastic limit with the tensile elastic limit.

7. In the case of ductile materials, the arrangement of the supports shall be such that longitudinal tension in the specimen due to the rigidity of the supports is avoided.

8. In the case of ductile materials, special care shall be used when determining the ultimate load. For this purpose it will be necessary when approaching the ultimate (i.e., the maximum) load, to make the speed of testing slow enough to enable the observer to note the maximum load.

In many cases, as in I and T beams, the maximum load can be easily ascertained, while in others, such as round or flat sections with short spans, it may not be possible to determine it exactly; but it will almost always be possible to determine it with sufficient accuracy for all practical purposes.

IV. METHODS FOR METALLOGRAPHIC TESTS OF METALS.

For general work the following notes are submitted:

Microscopic Examination.—For unhardened iron and steel, the following process has given satisfaction:

1. After polishing, examine under a magnification of 50 to 150 diameters. Look for slag or cinder in wrought iron, manganese sulphide, etc., in steel,* and size and shape of graphite in cast iron.

2. Etch with a saturated solution of picric acid in alcohol for 15 seconds. This reveals the pearlite† by turning it darker than the accompanying ferrite or cementite. In wrought iron, any pearlite present shows up, and the general appearance will sometimes show whether the material was puddled, etc., or made from reheated scrap. Those who wish to bring out the ferrite grains

*Arnold and Waterhouse, *Jour. Iron and Steel Inst.*, 1903, I, 136, E. F. Law, *Jour. Iron and Steel Inst.*, 1907 II, 04; Fay, *Proc. Am. Soc. Test. Mat.*, 1908, VIII, 74.

†Igevsky, *Rev. de Met.* II; Lejeune, *Rev. de Met.*, III, 426.

can do so easily and quickly by etching with nitric acid. To this end, nitric acid of 1.42 specific gravity should be diluted with either:

(*a*) 90 parts by volume of water to 10 of acid,
(*b*) 75 " " " " " " 25 " " or preferably
(*c*) 96 " " " " amyl alcohol to 4 of acid.

3. Near the eutectoid point, viz., 0.6 to 1.0 per cent. carbon, it is often difficult to distinguish between thin envelopes of ferrite and cementite. This difficulty can be overcome by etching with a solution of sodium picrate, which turns cementite dark brown or black but does not color the other constituents. The solution is made by adding 2 parts of picric acid to 98 parts of a solution containing 25 per cent. of caustic soda, and is used at 100° C.*

In order to interpret the results of such an etching, they should be compared with standard etched specimens.

In the case of hardened and tempered steel the indications are less decisive than in the case of unhardened steel, probably because the former class has been studied less than the latter. Coarse grain, segregation of constituents, presence of oxide, etc., are all signs of bad material. For etching use a solution of 4 per cent. nitric acid, specific gravity 1.42, in 96 of amyl alcohol. The time needed has to be found by trial in each case. Hence etch for 5 seconds, examine, re-etch if necessary,† etc.

Macroscopic Examination.—This method shows up defects due to segregation, blowholes, piping, and the like, and when used in connection with microscopic examination yields valuable information. A section is cut with a saw, filed smooth, and polished with No. 0 and No. 00 emery paper; it is then ready for etching.

Quite a number of etching reagents have been used‡ to develop the structure. Whichever solution is chosen, the specimen is first carefully washed with a strong caustic potash solution, well rinsed under the tap, and then immersed in the etching solution. The following may be mentioned:

* Kourbatoff, *Rev. de Met.*, III, 648.

† Kourbatoff, *Rev. de Met.*, III, 648; Lejeune, *Rev. de Met.*, III, 426; Heyn, Mitt. aus dem König. Materialsprüf. Gross-Lichterfelde, West, 1906, 29.

‡ Fremont, *Rev. de Met.*, V, 669. Ast. Internat. Assoc. Test. Materials, 1907. IVth Congress. Problem 2.

(*a*) Freshly prepared solution of 20 grams of I and 30 grams of KI, in 1,000 grams of water.
(*b*) Dilute HCl or H_2SO_4 up to 30 per cent. acid, using the 1.2 and 1.84 specific gravity respectively.
(*c*) Nitric acid, from 10 to 30 per cent. of the 1.42 specific gravity* acid in 90 to 70 per cent. of water.
(*d*) Concentrated HCl, specific gravity 1.2.
(*e*) A solution of 10 or 12 parts of double copper-ammonium chloride in 90 or 88 parts of water.

To bring out the structure of wrought iron rapidly, (*d*) is used, while (*c*) or (*b*) will bring it out more slowly.

For steel, first etch with (*a*), which shows up the segregation of carbon very well. Take care not to over-etch; 5 seconds is enough for some materials. To show up the impurities and the segregation of MnS, slag, etc., (*d*) acts quickly, but (*b*) gives better results though taking longer.

Some prefer light etching, say after 1 or 2 minutes, but an older method is to etch with (*b*) very deeply, indeed to a depth so great that several hours may be needed to reach it. In this way the segregation of the carbon and the impurities like slag and MnS are shown simultaneously. A picture of the object thus etched can be had by treating it like an engraving, i. e., inking it with printer's ink, and printing on white paper directly from it. A common letter-copying press is convenient for this printing.

* Stead, *Proc. Cleveland Inst. of Engrs.*, Sept., 1906, p. 3.

AMERICAN SOCIETY FOR TESTING MATERIALS

PHILADELPHIA, PA., U. S. A.

AFFILIATED WITH THE

INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.

STANDARD DEFINITIONS

OF

TERMS APPLICABLE TO MATERIALS RELATING TO ROADS AND PAVEMENTS.

ADOPTED AUGUST 5, 1912.

Bitumens are mixtures of native or pyrogenous hydrocarbons and their non-metallic derivatives, which may be gases, liquids, viscous liquids, or solids, and which are soluble in carbon disulphide.

Bituminous, containing bitumen or constituting the source of bitumen.

Dead oils are oils with a density greater than water which are distilled from tars.

Fixed carbon is the organic matter of the residual coke obtained upon burning hydrocarbon products in a covered vessel in the absence of free oxygen.

Free carbon in tars is organic matter which is insoluble in carbon disulphide.

SELECTED SPECIFICATIONS

FROM

MISCELLANEOUS SOURCES.

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AMERICAN RAILWAY ENGINEERING ASSOCIATION.

SPECIFICATIONS FOR CARBON STEEL RAILS.

1912.

INSPECTION.

Access to Works.

1. Inspectors representing the purchaser shall have free entry to the works of the manufacturer at all times while the contract is being executed, and shall have all reasonable facilities afforded them by the manufacturer to satisfy them that the rails have been made in accordance with the terms of the specifications.

Place for Tests.

2. All tests and inspections shall be made at the place of manufacture, prior to shipment, and shall be so conducted as not to interfere unnecessarily with the operation of the mill.

MATERIAL.

Material.

3. The material shall be steel made by the Bessemer or open-hearth process provided by the contract.

CHEMICAL REQUIREMENTS.

Chemical Composition.

4. The chemical composition of the steel from which the rails are rolled, determined as prescribed in Section 7, shall be within the following limits:

Elements.	For Bessemer Process.		For Open-hearth Process.	
	70 lb. and over, but under 85 lb.	85 to 100 lb. inclusive.	70 lb. and over, but under 85 lb.	85 to 100 lb. inclusive.
Carbon	0.40 to 0.50	0.45 to 0.55	0.53 to 0.66	0.63 to 0.76
Manganese	0.80 to 1.10	0.80 to 1.10	0.60 to 0.90	0.60 to 0.90
Silicon, not to exceed	0.20	0.20	0.20	0.20
Phosphorus, not to exceed	0.10	0.10	0.04	0.04

Modification of Carbon for Low Phosphorus.

5. When the material used at any mill is such that the average phosphorus content of the ingot metal used in the Bessemer process is running below 0.08 and in the open-hearth process is running below 0.03, and if it seems mutually desirable, the carbon may be increased at the rate of 0.035 for each 0.01 that the phosphorus content of the ingot metal used averages below 0.08 for Bessemer steel, or 0.03 for open-hearth steel.

Average Carbon.

6. It is desired that the percentage of carbon in an entire order of rails shall average as high as the mean percentage between the upper and lower limits specified.

Analyses.

7. In order to ascertain whether the chemical composition is in accordance with the requirements, analyses shall be furnished as follows:

(*a*) For Bessemer process the manufacturer shall furnish to the inspector, daily, carbon determinations for each heat before the rails are shipped, and two chemical analyses every twenty-four hours representing the average of the elements, carbon, manganese, silicon, phosphorus and sulphur contained in the steel, one for each day and night turn respectively. These analyses shall be made on drillings taken from the ladle test ingot not less than $\frac{1}{8}$ in. beneath the surface.

(*b*) For open-hearth process, the makers shall furnish the inspectors with a chemical analysis of the elements, carbon, manganese, silicon, phosphorus and sulphur, for each heat.

(*c*) On request of the inspector, the manufacturer shall furnish drillings from the test ingot for check analyses.

PHYSICAL REQUIREMENTS.

Physical Qualities.

8. Tests shall be made to determine:

(*a*) Ductility or toughness as opposed to brittleness.

(*b*) Soundness.

Method of Testing.

9. The physical qualities shall be determined by the drop test.

Drop Testing Machine.

10. The drop testing machine used shall be the standard of the American Railway Engineering Association.

(*a*) The tup shall weigh 2000 lb., and have a striking face with a radius of 5 in.

(*b*) The anvil block shall weigh 20,000 lb., and be supported on springs.

(*c*) The supports for the test pieces shall be spaced 3 ft. between centers and shall be a part of, and firmly secured to the anvil. The bearing surfaces of the supports shall have a radius of 5 in.

Pieces for Drop Test.

11. Drop tests shall be made on pieces of rail not less than 4 ft. and not more than 6 ft. long. These test pieces shall be cut from the top end of the top rail of the ingot, and marked on the base or head with gage marks 1 in. apart for 3 in. each side of the center of the test piece, for measuring the ductility of the metal.

Temperature of Test Pieces.

12. The temperature of the test pieces shall be between 60° and 100° F.

Height of Drop.

13. The test piece shall, at the option of the inspector, be placed head or base upwards on the supports, and be subjected to impact of the tup falling free from the following heights:

For 70-lb. rail.....16 feet
For 80, 85, and 90-lb. rail.....17 "
For 100-lb. rail.....18 "

Elongation or Ductility.

14. Under these impacts the rail under one or more blows shall show at least 6 per cent elongation for 1 in., or 5 per cent each for two consecutive inches of the 6-in. scale, marked as described in Section 11.

Permanent Set.

15. It is desired that the permanent set after one blow under the drop test shall not exceed that in the following table, and a record shall be made of this information:

Rail.			Permanent Set, Measured by Middle Ordinate in Inches in a Length of 3 Feet.	
Section.	Weight per Yard.	Moment of Inertia.	Bessemer Process.	O-H. Process.
A.R.A.-A.	100	48.94	1.65	1.45
A.R.A.-B.	100	41.30	2.05	1.80
A.R.A.-A.	90	38.70	1.90	1.65
A.R.A.-B.	90	32.30	2.20	2.00
A.R.A.-A.	80	28.80	2.85	2.45
A.R.A.-B.	80	25.00	3.15	2.85
A.R.A.-A.	70	21.05	3.50	3.10
A.R.A.-B.	70	18.60	3.85	3.50

Test to Destruction.

16. The test pieces which do not break under the first or subsequent blows shall be nicked and broken, to determine whether the interior metal is sound.

17. One piece shall be tested from each heat of Bessemer steel. **Bessemer Process Drop Tests.**

(*a*) If the test piece does not break at the first blow and shows the required elongation (Section 14), all of the rails of the heat shall be accepted, provided that the test piece when nicked and broken does not show interior defect.

(*b*) If the piece breaks at the first blow, or does not show the required elongation (Section 14), or if the test piece shows the required elongation but when nicked and broken shows interior defect, all of the top rails from that heat shall be rejected.

(*c*) A second test shall then be made of a test piece selected by the inspector from the top end of any second rail of the same heat, preferably of the same ingot. If the test piece does not break at the first blow, and shows the required elongation (Section 14), all of the remainder of the rails of the heat shall be accepted, provided that the test piece when nicked and broken does not show interior defect.

(*d*) If the piece breaks at the first blow, or does not show the required elongation (Section 14), or if the piece shows the required elongation but when nicked and broken shows interior defect, all of the second rails from that heat shall be rejected.

(*e*) A third test shall then be made of a test piece selected by the inspector from the top end of any third rail of the same heat, preferably of the same ingot. If the test piece does not break at the first blow and shows the required elongation (Section 14), all of the remainder of the rails of the heat shall be accepted, provided that the test piece when nicked and broken does not show interior defect.

(*f*) If the piece breaks at the first blow, or does not show the required elongation (Section 14), or if the piece shows the required elongation but when nicked and broken shows interior defect, all of the remainder of the rails from that heat shall be rejected.

18. Test pieces shall be selected from the second, middle and last full ingot of each open-hearth heat. **Open-hearth Process Drop Tests.**

(*a*) If two of these test pieces do not break at the first blow and show the required elongation (Section 14), all of the rails of the heat shall be accepted, provided that these test pieces when nicked and broken do not show interior defect.

(*b*) If two of the test pieces break at the first blow, or do not show the required elongation, or if any of the pieces that have been tested under the drop when nicked and broken show interior defect, all of the top rails from that heat shall be rejected

(*c*) Second tests shall then be made from three test pieces selected by the inspector from the top end of any second rails of the same heat, preferably of the same ingots. If two of these test pieces do not break at the first blow and show the required elongation (Section 14), all of the remainder of the rails of the heat shall be accepted, provided that the pieces that have been tested under the drop when nicked and broken do not show interior defect.

(*d*) If two of these test pieces break at the first blow or do not show the required elongation (Section 14), or if any of the pieces that have been tested under the drop when nicked and broken show interior defect, all of the second rails of the heat shall be rejected.

(*e*) Third tests shall then be made from three test pieces selected by the inspector from the top end of any third rails of the same heat, preferably of the same ingots. If two of these test pieces do not break at the first blow, and show the required elongation (Section 14), all of the remainder of the rails of the heat shall be accepted, provided that the pieces that have been tested under the drop when nicked and broken do not show interior defect.

(*f*) If two of these test pieces break at the first blow or do not show the required elongation (Section 14), or if any of the pieces that have been tested under the drop when nicked and broken show interior defect, all of the remainder of the rails from that heat shall be rejected.

No. 1 Rails. 19. No. 1 classification rails shall be free from injurious defects and flaws of all kinds.

No. 2 Rails. 20. (*a*) Rails, which, by reason of surface imperfections, or for causes mentioned in Section 30 hereof, are not classed as No. 1 rails, will be accepted as No. 2 rails, but No. 2 rails which contain imperfections in such number or of such character as will, in the judgment of the inspector, render them unfit for recognized No. 2 uses, will not be accepted for shipment.

(*b*) No. 2 rails to the extent of 5 per cent of the whole

order will be received. All rails accepted as No. 2 rails shall have the ends painted white and shall have two prick punch marks on the side of the web near the heat number near the end of the rails, so placed as not to be covered by the splice bars.

DETAILS OF MANUFACTURE.

21. The entire process of manufacture shall be in accordance with the best current state of the art. **Quality of Manufacture.**

22. Bled ingots shall not be used. **Bled Ingots.**

23. There shall be sheared from the end of the bloom, formed from the top of the ingot, sufficient metal to secure sound rails. **Discard.**

24. The standard length of rails shall be 33 ft., at a temperature of 60° F. Ten per cent of the entire order will be accepted in shorter lengths varying by 1 ft. from 32 ft. to 25 ft. A variation of $\frac{1}{4}$ in. from the specified lengths will be allowed. No. 1 rails less than 33 ft. long shall be painted green on both ends. **Lengths.**

25. The number of passes and speed of train shall be so regulated that on leaving the rolls at the final pass, the temperature of the rail will not exceed that which requires a shrinkage allowance at the hot saws, for a rail of 33 ft. in length and of 100-lb. section, of $6\frac{3}{4}$ in. and $\frac{1}{8}$ in. less for each 10-lb. decrease in section. **Shrinkage.**

26. The bars shall not be held for the purpose of reducing their temperature, nor shall any artificial means of cooling them be used after they leave the finishing pass. Rails, while on the cooling beds, shall be protected from snow and water. **Cooling.**

27. The section of rails shall conform as accurately as possible to the template furnished by the railroad company. A variation in height of $\frac{1}{64}$ in. less or $\frac{1}{32}$ in. greater than the specified height, and $\frac{1}{16}$ in. in width of flange, will be permitted, but no variation shall be allowed in the dimensions affecting the fit of the splice bars. **Section.**

28. The weight of the rails specified in the order shall be maintained as nearly as possible, after complying with the preceding section. A variation of 0.5 per cent from the calculated weight of section, as applied to an entire order, will be allowed. **Weight.**

Payment. 29. Rails accepted will be paid for according to actual weights.

Straightening. 30. The hot straightening shall be carefully done, so that gaging under the cold presses will be reduced to a minimum. Any rail coming to the straightening presses showing sharp kinks or greater camber than that indicated by a middle ordinate of 4 in. in 33 ft., for A. R. A. type of sections, or 5 in. for A. S. C. E. type of sections, will be at once classed as a No. 2 rail. The distance between the supports of rails in the straightening presses shall not be less than 42 in. The supports shall have flat surfaces and be out of wind.

Drilling. 31. Circular holes for joint bolts shall be drilled to conform accurately in every respect to the drawing and dimensions furnished by the railroad company.

Finishing. 32. (*a*) All rails shall be smooth on the heads, straight in line and surface, and without any twists, waves or kinks. They shall be sawed square at the ends, a variation of not more than $\frac{1}{32}$ in. being allowed; and burrs shall be carefully removed.

(*b*) Rails improperly drilled or straightened, or from which the burrs have not been removed, shall be rejected, but may be accepted after being properly finished.

Branding. 33. The name of the manufacturer, the weight and type of rail, and the month and year of manufacture shall be rolled in raised letters and figures on the side of the web. The number of the heat and a letter indicating the portion of the ingot from which the rail was made shall be plainly stamped on the web of each rail, where it will not be covered by the splice bars. The top rails shall be lettered "A," and the succeeding ones "B," "C," "D," etc., consecutively; but in case of a top discard of twenty or more per cent, the letter "A" will be omitted. Open-hearth rails shall be branded or stamped "O. H." All markings of rails shall be done so effectively that the marks may be read as long as the rails are in service.

Separate Classes. 34. All classes of rails shall be kept separate from each other.

Loading. 35. All rails shall be loaded in the presence of the inspector.

AMERICAN RAILWAY ENGINEERING ASSOCIATION.

GENERAL SPECIFICATIONS FOR STEEL RAILWAY BRIDGES.

1910

V. MATERIAL.

85. Steel shall be made by the open-hearth process. **Steel.**

86. The chemical and physical properties shall conform to the following limits: **Properties.**

Elements Considered.	Structural Steel.	Rivet Steel.	Steel Castings.
Phosphorus, maximum.. Basic..	0.04 per cent.	0.04 per cent.	0.05 per cent.
Acid...	0.06 "	0.04 "	0.08 "
Sulphur, maximum.....	0.05 "	0.04 "	0.05 "
Ultimate tensile strength. Pounds per sq. in.....	Desired. 60,000	Desired. 50,000	Not less than 65,000
Elong., min. per cent. in 8 ins. (Fig. 1).....	1,500,000* Ult. tensile str'gth	1,500,000 Ult. tensile str'gth	15 per cent.
Elong., min. per cent. in 2 ins. (Fig. 2).....	22		Silky or fine granular
Character of fracture.....	Silky	Silky	
Cold bends without fracture.....	180° flat†	180° flat‡	90° $d=3t$

* See Paragraph 96. † See Paragraphs 97, 98, and 99. ‡ See Paragraph 100.

The yield point, as indicated by the drop of beam, shall be recorded in the test reports.

87. In order that the ultimate strength of full-sized annealed eye-bars may meet the requirements of Paragraph 163§, the ultimate strength in test specimens may be determined by the manufacturers; all other tests than those for ultimate strength shall conform to the above requirements.

§ 163. In eye-bar tests. the minimum ultimate strength shall be 55,000 lbs. per sq. in. The elongation in 10 ft., including fracture, shall be not less than 15 per cent. Bars shall generally break in the body and the fracture shall be silky or fine granular, and the elastic limit as indicated by the drop of the mercury shall be recorded. Should a bar break in the head and develop the specified elongation, ultimate strength and character of fracture, it shall not be cause for rejection, provided not more than one-third of the total number of bars break in the head (see 136).

Allowable Variations.

88. If the ultimate strength varies more than 4,000 lbs. from that desired, a retest shall be made on the same gauge, which, to be acceptable, shall be within 5,000 lbs. of the desired ultimate.

Chemical Analyses.

89. Chemical determinations of the percentages of carbon, phosphorus, sulphur and manganese shall be made by the manufacturer from a test ingot taken at the time of the pouring of each melt of steel, and a correct copy of such analysis shall be furnished to the engineer or his inspector. Check analyses shall be made from finished material, if called for by the purchaser, in which

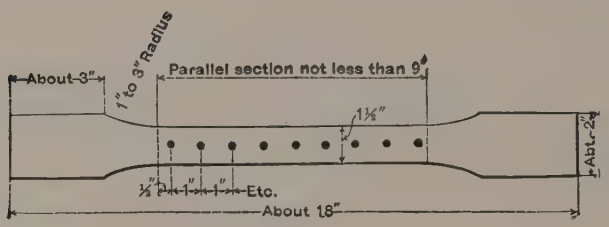

FIG. 1.

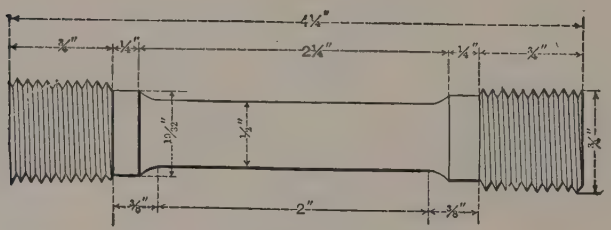

FIG. 2.

case an excess of 25 per cent. above the required limits will be permitted.

Specimens.

90. Plate, shape and bar specimens for tensile and bending tests shall be made by cutting coupons from the finished product, which shall have both faces rolled and both edges milled to the form shown by Fig. 1; or with both edges parallel; or they may be turned to a diameter of $\frac{3}{4}$ in. for a length of at least 9 ins., with enlarged ends.

91. Rivet rods shall be tested as rolled.

92. Pin and roller specimens shall be cut from the finished rolled or forged bar, in such manner that the center of the specimen

shall be one inch from the surface of the bar. The specimen for tensile test shall be turned to the form shown by Fig. 2. The specimen for bending test shall be 1 in. by $\frac{1}{2}$ in. in section.

93. For steel castings the number of tests will depend on the character and importance of the castings. Specimens shall be cut cold from coupons molded and cast on some portion of one or more castings from each melt or from the sink heads, if the heads are of sufficient size. The coupon or sink head, so used, shall be annealed with the casting before it is cut off. Test specimens to be of the form prescribed for pins and rollers.

Specimens of Rolled Steel.

94. Rolled steel shall be tested in the condition in which it comes from the rolls.

Number of Tests.

95. At least one tensile and one bending test shall be made from each melt of steel as rolled. In case steel differing $\frac{3}{8}$ in. and more in thickness is rolled from one melt, a test shall be made from the thickest and thinnest material rolled.

Modification in Elongation.

96. A deduction of 1 per cent. will be allowed from the specified percentage for elongation, for each $\frac{1}{8}$ in. in thickness above $\frac{3}{4}$ in.

Bending Tests.

97. Bending tests may be made by pressure or by blows. Plates, shapes and bars less than 1 in. thick shall bend as called for in Paragraph 86.

Thick Material.

98. Full-sized material for eye-bars and other steel 1 in. thick and over, tested as rolled, shall bend cold 180° around a pin, the diameter of which is equal to twice the thickness of the bar, without fracture on the outside of bend.

Bending Angles.

99. Angles $\frac{3}{4}$ in. and less in thickness shall open flat, and angles $\frac{1}{2}$ in. and less in thickness shall bend shut, cold, under blows of a hammer, without sign of fracture. This test shall be made only when required by the inspector.

Nicked Bends.

100. Rivet steel, when nicked and bent around a bar of the same diameter as the rivet rod, shall give a gradual break and a fine silky uniform fracture.

Finish.

101. Finished material shall be free from injurious seams, flaws, cracks, defective edges or other defects, and have a smooth, uniform and workmanlike finish. Plates 36 ins. in width and under shall have rolled edges.

Melt Numbers.

102. Every finished piece of steel shall have the melt number and the name of the manufacturer stamped or rolled upon it.

Steel for pins and rollers shall be stamped on the end. Rivet and lattice steel and other small parts may be bundled with the above marks on an attached metal tag.

Defective Material.

103. Material which, subsequent to the above tests at the mills, and its acceptance there, develops weak spots, brittleness, cracks or other imperfections, or is found to have injurious defects, will be rejected at the shop and shall be replaced by the manufacturer at his own cost.

Variation in Weight.

104. A variation in cross-section or weight of each piece of steel of more than $2\frac{1}{2}$ per cent. from that specified will be sufficient cause for rejection, except in case of sheared plates, which will be covered by the following permissible variations, which are to apply to single plates, when ordered to weight:

105. Plates $12\frac{1}{2}$ lbs. per sq. ft. or heavier:

(*a*) Up to 100 ins. wide, $2\frac{1}{2}$ per cent. above or below the prescribed weight.

(*b*) 100 ins. wide and over, 5 per cent. above or below.

106. Plates under $12\frac{1}{2}$ lbs. per sq. ft.:

(*a*) Up to 75 ins. wide, $2\frac{1}{2}$ per cent. above or below.

(*b*) 75 ins. and up to 100 ins. wide, 5 per cent. above or 3 per cent. below.

(*c*) 100 ins. wide and over, 10 per cent. above or 3 per cent. below.

107. Plates when ordered to gauge will be accepted if they measure not more than 0.01 in. below the ordered thickness.

108. An excess over the nominal weight, corresponding to the dimensions on the order, will be allowed for each plate, if not more than that shown in the following table, one cubic inch of rolled steel being assumed to weigh 0.2833 lb.:

Thickness Ordered, ins.	Nominal Weights, lbs.	Width of Plate.			
		Up to 75 ins.	75 ins. and up to 100 ins.	100 ins. and up to 115 ins.	Over 115 ins.
1/4	10.20	10 per cent.	14 per cent.	18 per cent.	....
5/16	12.75	8 "	12 "	16 "	....
3/8	15.30	7 "	10 "	13 "	17 per cent.
7/16	17.85	6 "	8 "	10 "	13 "
1/2	20.40	5 "	7 "	9 "	12 "
9/16	22.95	$4\frac{1}{2}$ "	$6\frac{1}{2}$ "	$8\frac{1}{2}$ "	11 "
5/8	25.50	4 "	6 "	8 "	10 "
Over 5/8	.....	$3\frac{1}{2}$ "	5 "	$6\frac{1}{2}$ "	9 "

109. Except where chilled iron is specified, castings shall be made of tough gray iron, with sulphur not over 0.10 per cent. They shall be true to pattern, out of wind and free from flaws and excessive shrinkage. If tests are demanded, they shall be made on the "Arbitration Bar" of the American Society for Testing Materials, which is a round bar $1\frac{1}{4}$ ins. in diameter and 15 ins. long. The transverse test shall be made on a supported length of 12 ins. with load at middle. The minimum breaking load so applied shall be 2,900 lbs., with a deflection of at least 0.1 in. before rupture. **Cast Iron.**

110. Wrought iron shall be double-rolled, tough, fibrous and uniform in character. It shall be thoroughly welded in rolling and be free from surface defects. When tested in specimens of the form of Fig. 1, or in full-sized pieces of the same length, it shall show an ultimate strength of at least 50,000 lbs. per sq. in., an elongation of at least 18 per cent. in 8 ins., with fracture wholly fibrous. Specimens shall bend cold, with the fiber, through 135°, without sign of fracture, around a pin the diameter of which is not over twice the thickness of the piece tested. When nicked and bent, the fracture shall show at least 90 per cent. fibrous. **Wrought Iron.**

VI. INSPECTION AND TESTING AT THE MILLS.

111. The purchaser shall be furnished complete copies of mill orders, and no material shall be rolled nor work done before the purchaser has been notified where the orders have been placed, so that he may arrange for the inspection. **Mill Orders.**

112. The manufacturer shall furnish all facilities for inspecting and testing the weight and quality of all material at the mill where it is manufactured. He shall furnish a suitable testing machine for testing the specimens, as well as prepare the pieces for the machine, free of cost. **Facilities for Inspection.**

113. When an inspector is furnished by the purchaser to inspect material at the mills, he shall have full access, at all times, to all parts of mills where material to be inspected by him is being manufactured. **Access to Mills.**

THE ASSOCIATION OF AMERICAN STEEL MANUFACTURERS.

MANUFACTURERS' STANDARD SPECIFICATIONS

FOR

STRUCTURAL STEEL.

REVISED 1912.

Grades. 1. These specifications cover three classes of structural steel, namely:

Class A steel, to be used for railway bridges and ships.
Class B steel, to be used for buildings, highway bridges, train sheds and similar structures.
Class C steel, to be used for structural rivets.

I. MANUFACTURE.

Process. 2. Steel for Classes A and C shall be made by the open-hearth process. Steel for Class B may be made either by the open-hearth or by the Bessemer process.

II. CHEMICAL PROPERTIES AND TESTS.

Chemical Composition. 3. The steel shall conform to the following requirements as to chemical composition:

Elements Considered.	Class A Steel.	Class B Steel.	Class C Steel.
Phosphorus, max., per cent { Basic open-hearth	0.04	0.06	0.04
Phosphorus, max., per cent { Acid open-hearth	0.06	0.08	0.04
Phosphorus, max., per cent { Bessemer	....	0.10	....
Sulphur, max., per cent	0.05	.....	0.045

Ladle Analyses. 4. To determine whether the material conforms to the requirements specified in Section 3, an analysis shall be made

by the manufacturer from a test ingot taken during the pouring of each melt. A copy of this analysis shall be given to the purchaser or his representative, if requested.

Check Analyses.

5. A check analysis of Class A and Class C steel may be made by the purchaser from finished material representing each melt, in which case an excess of 25 per cent above the requirements specified in Section 3 shall be allowed.

III. PHYSICAL PROPERTIES AND TESTS.

Tension Tests.

6. The steel shall conform to the following requirements as to tensile properties:

Properties Considered.	Class A Steel.	Class B Steel.	Class C Steel.
Tensile strength, lb. per sq. in.	55 000 – 65 000	55 000 – 65 000[1]	46 000 – 56 000
Yield point, minimum, lb. per sq. in.	0.5 tens. str.	0.5 tens. str.	0.5 tens. str.
Elongation in 8 in., min., per cent.	1 400 000[2] / tens. str.	1 400 000[2] / tens. str.	1 400 000 / tens. str.
Elongation in 2 in., min., per cent (Fig. 2)	22	22	.....

[1] See Section 8.

[2] See Section 9.

Yield Point.

7. The yield point shall be determined by the drop of the beam of the testing machine.

Modification in Tensile Strength.

8. Class B steel may have tensile strength up to 70,000 lb. maximum, provided the elongation is not less than the percentage required for 65,000-lb. tensile strength.

Modifications in Elongation.

9. (*a*) For material over $\frac{3}{4}$ in. in thickness, a deduction of 1 from the percentage of elongation in 8 in. specified for Classes A and B in Section 6 shall be made for each increase of $\frac{1}{8}$ in. in thickness above $\frac{3}{4}$ in., to a minimum of 18 per cent.

(*b*) For material under $\frac{5}{16}$ in. in thickness, a deduction of 2.5 from the percentage of elongation in 8 in. specified for Classes A and B in Section 6 shall be made for each decrease of $\frac{1}{16}$ in. in thickness below $\frac{5}{16}$ in.

Character of Fracture.

10. All broken tension test specimens shall show a silky fracture.

Bend Tests.

11. (*a*) The test specimen for plates, shapes and bars shall bend cold through 180 deg. without fracture on the outside of the bent portion, as follows: For material $\frac{3}{4}$ in. and under in thickness, flat on itself; for material over $\frac{3}{4}$ in. up to $1\frac{1}{4}$ in. in thickness,

around a pin the diameter of which is equal to $1\frac{1}{2}$ times the thickness of the specimen; and for material over $1\frac{1}{4}$ in. in thickness, around a pin the diameter of which is equal to twice the thickness of the specimen.

(*b*) The test specimen for pins and rollers shall bend cold through 180 deg. around a 1-in. pin without fracture on the outside of the bent portion.

(*c*) A rivet rod shall bend cold through 180 deg. flat on itself without fracture on the outside of the bent portion.

(*d*) Bend tests may be made by pressure or by blows.

Test Specimens. 12. (*a*) Tension and bend test specimens shall be taken from the finished rolled or forged product, and shall not be annealed or otherwise treated, except as specified in Section 13.

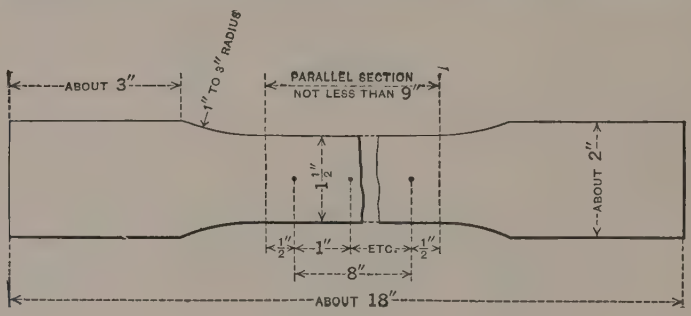

FIG. 1.

(*b*) Tension and bend test specimens for plates, shapes and bars, except as specified in Paragraph (*c*) shall be of the full thickness of material as rolled, and with both edges milled to the form and dimensions shown in Fig. 1, or may have both edges parallel.

(*c*) Tension and bend test specimens for plates and bars (except eye-bar flats) over $1\frac{1}{2}$ in. in thickness or diameter may be turned or planed to a diameter or thickness of at least $\frac{3}{4}$ in. for a length of at least 9 in.

(*d*) Tension and bend test specimens for pins and rollers shall be taken parallel to the axis, 1 in. from the surface of the bar. Tension test specimens shall be of the form and dimensions shown in Fig. 2. Bend test specimens shall be 1 in. by $\frac{1}{2}$ in. in section.

(*e*) Rivet bars shall be tested in full-size section as rolled.

13. Test specimens for material which is to be annealed or otherwise treated before use, shall be cut from properly annealed or similarly treated short lengths of the full section of the piece. **Annealed Specimens.**

14. (*a*) At least one tension test and one bend test shall be made from each melt. If material from one melt differs $\frac{3}{8}$ in. or more in thickness, tests shall be made from both the thickest and the thinnest material rolled. **Number of Tests.**

(*b*) If any test specimen develops flaws, or if an 8-in. tension test specimen breaks outside the middle third of the gage length, or if a 2-in. tension test specimen breaks outside the gage length, it may be discarded and another specimen substituted therefor.

(*c*) Material intended for fillers or ornamental purposes will not be subject to test.

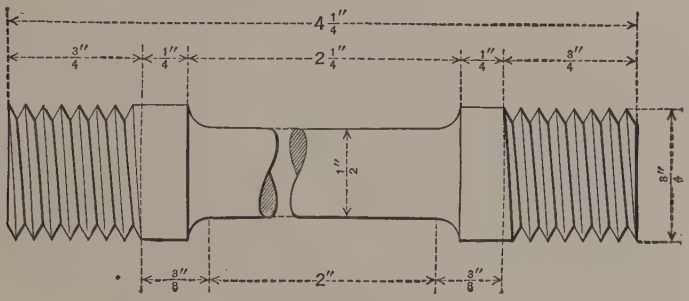

FIG. 2.

IV. PERMISSIBLE VARIATIONS IN WEIGHT AND GAGE.

15. (*a*) The sectional area or weight of each structural shape or rolled-edge plate shall not vary more than 2.5 per cent from theoretical or specified amounts. **Permissible Variations.**

(*b*) The thickness or weight of each sheared plate shall conform to the schedule of permissible variations, Manufacturers' Standard practice, appended to these specifications.[1]

(*c*) The weight of angles, tees, zees and channels of bar sizes, and the dimensions of rounds, squares, hexagons and flats, shall conform to the Manufacturers' Standard practice governing the allowable variations in size and weight of hot-rolled bars, appended to these specifications.[1]

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[1] See pages 385–387.

V. FINISH

Finish

16. The finished material shall be free from injurious defects, and shall have a workmanlike finish.

VI. MARKING.

Marking.

17. The name of the manufacturer and the melt number shall be legibly marked, stamped or rolled upon all finished material, except that each pin and roller shall be stamped on the end. Rivet and lattice steel and other small pieces may be shipped in securely fastened bundles, with the above marks legibly stamped on attached metal tags. Test specimens shall have their numbers plainly marked or stamped.

VII. INSPECTION AND REJECTION.

Inspection.

18. The inspector representing the purchaser shall have free entry, at all times while work on the contract of the purchaser is being performed, to all parts of the manufacturer's works which concern the manufacture of the material ordered. The manufacturer shall afford the inspector, free of cost, all reasonable facilities to satisfy him that the material is being furnished in accordance with these specifications. All tests and inspection shall be made at the place of manufacture prior to shipment, and shall be so conducted as not to interfere unnecessarily with the operation of the works.

Rejection.

19. Material which, subsequent to the above tests at the mills and its acceptance there, develops weak spots, brittleness, cracks or other imperfections, or is found to have injurious defects, may be rejected at the shop, and shall then be replaced by the manufacturer at his own cost.

THE ASSOCIATION OF AMERICAN STEEL MANUFACTURERS.

MANUFACTURERS' STANDARD SPECIFICATIONS

FOR

BOILER STEEL.

REVISED 1912.

1. There shall be three grades of steel for boilers, namely: Flange, firebox, and boiler rivet. **Grades.**

I. MANUFACTURE.

2. The steel shall be made by the open-hearth process. **Process.**

II. CHEMICAL PROPERTIES AND TESTS.

3. The steel shall conform to the following requirements as to chemical composition: **Chemical Composition.**

Elements Considered.	Flange Steel.	Firebox Steel.	Boiler Rivet Steel.
Manganese, per cent	0.30 to 0.60	0.30 to 0.50	0.30 to 0.50
Phosphorus, max., per cent { Basic	0.04	0.035	0.04
Phosphorus, max., per cent { Acid	0.05	0.04	0.04
Sulphur, max., per cent	0.05	0.04	0.045

4. To determine whether the material conforms to the requirements specified in Section 3, an analysis shall be made by the manufacturer from a test ingot taken during the pouring of each melt. A copy of this analysis shall be given to the purchaser or his representative. **Ladle Analyses.**

5. A check analysis may be made by the purchaser from a broken tension test specimen representing each plate as rolled, **Check Analyses.**

and this analysis shall conform to the requirements specified in Section 3.

III. PHYSICAL PROPERTIES AND TESTS.

Tension Tests.

6. The steel shall conform to the following requirements as to tensile properties:

Properties Considered.	Flange Steel.	Firebox Steel.	Boiler Rivet Steel.
Tensile strength, lb. per sq. in.....	55 000–65 000	55 000–62 000	45 000–55 000
Yield point, min., lb. per sq. in.....	0.5 tens. str.	0.5 tens. str.	0.5 tens. str.
Elongation in 8 in., min., per cent.....	$\frac{1\,450\,000^1}{\text{tens. str.}}$	$\frac{1\,450\,000^1}{\text{tens. str.}}$	$\frac{1\,450\,000}{\text{tens. str.}}$

[1] See Section 8.

Yield Point.

7. The yield point shall be determined by the drop of the beam of the testing machine.

Modifications in Elongation.

8. (*a*) For plates over $\frac{3}{4}$ in. in thickness, a deduction of 0.5 from the specified percentage of elongation will be allowed for each increase of $\frac{1}{8}$ in. in thickness above $\frac{3}{4}$ in., to a minimum of 20 per cent.

(*b*) For plates under $\frac{5}{16}$ in. in thickness, a deduction of 2.5 from the percentage of elongation specified in Section 6 shall be made for each decrease of $\frac{1}{16}$ in. in thickness below $\frac{5}{16}$ in.

Bend Tests.

9. (*a*) Cold-bend tests shall be made on the material as rolled.

(*b*) Quench-bend test specimens, before bending, shall be heated to a light cherry red as seen in the dark (about 1200 ° F.), and quenched in water the temperature of which is about 80° F.

(*c*) Specimens for cold-bend and quench-bend tests of flange and firebox steel shall bend through 180 deg. without fracture on the outside of the bent portion, as follows: For material $\frac{3}{4}$ in. and under in thickness, flat on themselves; for material over $\frac{3}{4}$ in. up to $1\frac{1}{4}$ in. in thickness, around a pin the diameter of which is equal to the thickness of the specimen; and for material over $1\frac{1}{4}$ in. in thickness, around a pin the diameter of which is equal to $1\frac{1}{2}$ times the thickness of the specimen.

(*d*) Specimens for cold-bend and quench-bend tests of boiler rivet steel shall bend cold through 180 deg. flat on themselves without fracture on the outside of the bent portion.

(*e*) Bend tests may be made by pressure or by blows.

Test Specimens.

10. (*a*) Tension and bend test specimens for plates shall be taken from the finished product, and shall be of the full thickness of material as rolled. Tension test specimens shall be of the form and dimensions shown in Fig. 1. Bend test specimens shall be $1\frac{1}{2}$ in. to $2\frac{1}{2}$ in. wide, and shall have the sheared edges milled or planed.

(*b*) The tension and bend test specimens for rivet bars shall be of the full-size section of material as rolled.

Number of Tests.

11. (*a*) One tension, one cold-bend, and one quench-bend test shall be made from each plate as rolled.

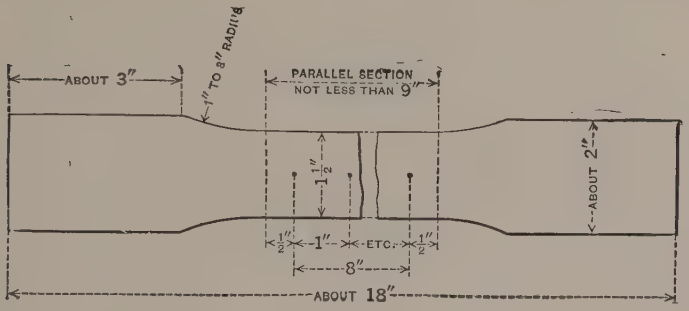

FIG. 1.

(*b*) Two tension, two cold-bend, and two quench-bend tests shall be made for each melt of rivet steel.

(*c*) If any test specimen develops flaws, or if a tension test specimen breaks outside the middle third of the gage length, it may be discarded and another specimen substituted therefor.

IV. PERMISSIBLE VARIATIONS IN WEIGHT AND GAGE.

Permissible Variations.

12. (*a*) The thickness or weight of each sheared plate shall conform to the schedule of permissible variations, Manufacturers' Standard practice, appended to these specifications.[1]

(*b*) The dimensions of rivet bars shall conform to the Manufacturers' Standard practice governing allowable variations in the size of hot-rolled bars, appended to these specifications.[1]

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[1] See pages 385–387.

V. FINISH.

Finish.

13. The finished material shall be free from injurious defects, and shall have a workmanlike finish.

VI. MARKING.

Marking.

14. The melt or slab number, name of the manufacturer, grade, and the minimum tensile strength for its grade as specified in Section 6 shall be legibly stamped on each plate. The melt or slab number shall be legibly stamped on each test specimen representing that melt or slab.

VII. INSPECTION AND REJECTION.

Inspection.

15. The inspector representing the purchaser shall have free entry, at all times while work on the contract of the purchaser is being performed, to all parts of the manufacturer's works which concern the manufacture of the material ordered. The manufacturer shall afford the inspector, free of cost, all reasonable facilities to satisfy him that the material is being furnished in accordance with these specifications. All tests and inspection shall be made at the place of manufacture prior to shipment, and shall be so conducted as not to interfere unnecessarily with the operation of the works.

Rejection.

16. Material which, subsequent to the above tests at the mills and its acceptance there, develops weak spots, brittleness, cracks or other imperfections, or is found to have injurious defects, may be rejected at the shop, and shall then be replaced by the manufacturer at his own cost.

APPENDIX.

MANUFACTURERS' STANDARD PRACTICE.

Permissible Variations in Sheared Plates.

Adopted 1896.

The thickness or weight of each sheared plate shall not vary more than the permissible variations given below:

(*a*) *When Ordered to Weight.*—For plates $12\frac{1}{2}$ lb. per sq. ft. or over.

Under 100 in. in width, 2.5 per cent above or below the specified weight;

100 in. in width and over, 5 per cent above or below the specified weight.

For plates under $12\frac{1}{2}$ lb. per sq. ft.:

Under 75 in. in width, 2.5 per cent above or below the specified weight;

75 to 100 in. in width, 5 per cent above or 3 per cent below the specified weight;

100 in. in width and over, 10 per cent above or 3 per cent below the specified weight.

(*b*) *When Ordered to Gage.*—The thickness of each plate shall not vary more than 0.01 in. under that ordered.

An excess over the nominal weight corresponding to the dimensions on the order shall be allowed for each plate, if not more than that shown in the following table, one cubic inch of rolled steel being assumed to weigh 0.2833 lb.:

TABLE OF ALLOWANCES FOR OVERWEIGHT FOR SHEARED PLATES WHEN ORDERED TO GAGE.

Thickness Ordered, in.	Nominal Weight, lb. per sq. ft.	Allowable Excess (expressed as percentage of Nominal Weight). For Width of Plate as follows:						
		Under 50 in.	50 in. to 70 in.	70 in. and over.	Under 75 in.	75 in. to 100 in.	100 in. to 115 in.	115 in. and over.
$\frac{1}{8}$ to $\frac{5}{32}$	5.10 to 6.37	10	15	20	..	..	..	..
$\frac{5}{32}$ " $\frac{3}{16}$	6.37 " 7.65	8.5	12.5	17	..	..	..	..
$\frac{3}{16}$ " $\frac{1}{4}$	7.65 "10.20	7	10	15	..	..	..	..
$\frac{1}{4}$	10.20	..	..	..	10	14	18	..
$\frac{5}{16}$	12.75	..	..	..	8	12	16	..
$\frac{3}{8}$	15.30	..	..	..	7	10	13	17
$\frac{7}{16}$	17.85	..	..	..	6	8	10	13
$\frac{1}{2}$	20.40	..	..	..	5	7	9	12
$\frac{9}{16}$	22.95	..	..	..	4.5	6.5	8.5	11
$\frac{5}{8}$	25.50	..	..	..	4	6	8	10
Over $\frac{5}{8}$	..	..	..	..	3.5	5	6.5	9

STANDARD PRACTICE GOVERNING THE ALLOWABLE VARIATIONS IN THE SIZE AND WEIGHT OF HOT-ROLLED BARS.

ADOPTED 1910.

I. ALLOWABLE VARIATIONS IN THE WEIGHT OF BAR SIZES[1] OF ANGLES, TEES, ZEES AND CHANNELS.

For bar sizes of angles, tees, zees and channels the following average variations in weight will be permitted for sections of the various dimensions and thicknesses stated, namely:

Dimensions.	Thickness.	Variation in Weight, Over and Under.
Any dimension over $1\frac{1}{2}$ in.....	Over $\frac{3}{16}$ in.	4 per cent
All dimensions $1\frac{1}{2}$ in. and less.....	Over $\frac{3}{16}$ in.	5 " "
Any dimension over $1\frac{1}{2}$ in.....	$\frac{3}{16}$ in. and less	6 " "
All dimensions $1\frac{1}{2}$ in. and less.....	$\frac{3}{16}$ in. and less	7 " "

[1] A channel is in "bar" size when its greatest dimension is less than 3 in. An angle, tee or zee is in "bar" size when its greatest dimension is less than 3 in.; or when it is 3 in. or more and at the same time the thickness is less than $\frac{1}{4}$ in.

II. ALLOWABLE VARIATIONS IN THE SIZE OF HOT-ROLLED BARS.

(a) ROUNDS, SQUARES, HEXAGONS.

		Variation in Size. Under.	Over.
Up to and including	$\frac{1}{2}$ in.	0.007 in.	0.007 in.
Over $\frac{1}{2}$ in. " "	1 "	0.010 "	0.010 "
Over 1 " " "	2 "	$\frac{1}{64}$ "	$\frac{1}{32}$ "
Over 2 " " "	3 "	$\frac{1}{32}$ "	$\frac{3}{64}$ "
Over 3 " " "	5 "	$\frac{1}{32}$ "	$\frac{3}{32}$ "
Over 5 " " "	8 "	$\frac{1}{16}$ "	$\frac{1}{8}$ "

(b) FLATS.

Width of Flats.	Variation in Width, Inches.		VARIATION IN THICKNESS, UNDER AND OVER, INCHES. Thickness of Flats			
	Under	Over	$\frac{3}{16}$ in. and under	Over $\frac{3}{16}$ in. up to $\frac{1}{2}$ in.	Over $\frac{1}{2}$ in. up to 1 in.	Over 1 in. up to 2 in.
Up to and including 1 in.	$\frac{1}{64}$	$\frac{1}{32}$	0.006	0.003	0.010	..
Over 1 in. up to and including 2 in.	$\frac{1}{32}$	$\frac{3}{64}$	0.008	0.012	0.015	$\frac{1}{32}$
Over 2 in. up to and including 4 in.	$\frac{3}{64}$	$\frac{1}{16}$	0.010	0.015	0.020	$\frac{1}{32}$
Over 4 in. up to and including 6 in.	$\frac{1}{16}$	$\frac{3}{32}$	0.010	0.015	0.020	$\frac{1}{32}$

THE ASSOCIATION OF AMERICAN STEEL MANUFACTURERS.

MANUFACTURERS' STANDARD SPECIFICATIONS FOR BESSEMER STEEL RAILS.

Process of Manufacture.

1. The entire process of manufacture and testing shall be in accordance with the best current practice, and special care shall be taken to conform to the following instructions:

Ingots shall be kept in a vertical position in the pit heating furnaces until ready to be rolled, or until the metal in the interior has time to solidify.

No bled ingots shall be used.

Sufficient material shall be discarded from the top of ingot to insure sound rails.

Chemical Composition.

2. Rails of the various weights per yard specified below shall conform to the following limits in chemical composition:

	50 to 59 lbs. inclusive, per cent.	60 to 69 lbs. inclusive, per cent.	70 to 79 lbs. inclusive, per cent.	80 to 89 lbs. inclusive, per cent.	90 to 100 lbs. inclusive, per cent.
Carbon	0.35 to 0.45	0.38 to 0.48	0.45 to 0.55	0.48 to 0.58	0.50 to 0.60
Phosphorus, not over	0.10	0.10	0.10	0.10	0.10
Silicon, not over	0.20	0.20	0.20	0.20	0.20
Manganese	0.70 to 1.00	0.70 to 1.00	0.75 to 1.05	0.80 to 1.10	0.80 to 1.10

Drop Test.

3. One drop test shall be made on a piece of rail not more than 6 ft. long, selected from every fifth blow of steel. The rail shall be placed head upwards on the supports and the various sections shall be subjected to the following impact tests:

Weight of Rail, lbs. per yd.	Height of Drop, ft.
45 to and including 55	14
More than 55 " " " 65	15
" " 65 " " " 75	16
" " 75 " " " 85	17
" " 85 " " " 100	18

If any rail break when subjected to the drop test, two additional tests will be made of other rails from the same blow of steel, and if either of these latter tests fail all the rails of the blow which they represent will be rejected, but if both of these additional test pieces meet the requirements all the rails of the blow which they represent will be accepted. If the rails from the tested blow shall be rejected for failure to meet the requirements of the drop test as above specified, two other rails will be subjected to the same tests, one from the blow next preceding, and one from the blow next succeeding the rejected blow. In case the first test taken from the preceding or succeeding blow shall fail, two additional tests shall be taken from the same blow of steel, the acceptance or rejection of which shall also be determined as specified above, and if the rails of the preceding or succeeding blow shall be rejected, similar tests may be taken from the previous or following blows, as the case may be, until the entire group of five blows is tested if necessary.

The acceptance or rejection of all the rails from any blow will depend upon the result of the tests thereof.

Drop-Testing Machine.

4. The drop-test machine shall have a tup of 2000 lbs. weight, the striking face of which shall have a radius of 5 ins., and the test rail shall be placed head upwards on solid supports 3 ft. apart. The anvil block shall weigh at least 20,000 lbs. and the supports shall be a part of, or firmly secured to, the anvil.

The report of the drop test shall state the atmospheric temperature at the time the tests were made.

Sample for Chemical Analysis.

5. The manufacturer shall furnish the inspector, daily, with carbon determinations of each blow, and a complete chemical analysis every twenty-four hours, representing the average of the other elements contained in the steel. These analyses shall be made on drillings taken from a small test ingot.

Section.

6. Unless otherwise specified, the section of rail shall be the American Standard, recommended by the American Society of Civil Engineers, and shall conform as accurately as possible to the templet furnished by the railroad company, consistent with Paragraph 7, relative to specified weight. A variation in height of $\frac{1}{64}$ in. less and $\frac{1}{32}$ in. greater than the specified height will be permitted. A perfect fit of the splice bars, however, shall be maintained at all times.

Weight. 7. The weight of the rails shall be maintained as nearly as possible, after complying with Paragraph 6, to that specified in contract. A variation of one-half per cent. for an entire order will be allowed. Rails shall be accepted and paid for according to actual weight.

Length. 8. The standard length of rails shall be 30 or 33 ft. Ten per cent. of the entire order will be accepted in shorter lengths, varying by even feet down to 24 ft. A variation of $\frac{1}{4}$ in. in length from the length specified will be allowed.

Drilling. 9. Circular holes for splice bars shall be drilled in accordance with specifications of purchaser. They shall be accurate to drawing and dimensions furnished, in every respect, and free from burrs.

Finish. 10. Rails shall be straightened while cold, smooth on head, sawed square at ends, and prior to shipment shall have the burr occasioned by the saw-cutting removed, and the ends made clean. No. 1 rails shall be free from injurious defects and flaws of all kinds.

Branding. 11. The name of the maker and the month and year of manufacture shall be rolled in raised letters on the side of the web, and the number of the heat shall be stamped on each rail.

Inspection. 12. The inspector, representing the purchaser, shall have all reasonable facilities afforded to him by the manufacturer to satisfy him that the finished material is furnished in accordance with these specifications. All tests and inspections shall be made at the place of manufacture, prior to shipment.

No. 2 Rails. 13. Rails which possess any injurious physical defects, or for any other cause are not suitable for first quality, shall be considered No. 2 rails.

Designation of No. 2 Rails, and Short Lengths of No. 1 Rails. 14. Both ends of all seconds or No. 2 rails to be painted white. Both ends of all short-length first quality or No. 1 rails to be painted green.

UNITED STATES STEEL PRODUCTS COMPANY

STANDARD SPECIFICATIONS FOR BESSEMER AND OPEN-HEARTH STEEL RAILS.

MARCH 21, 1910.

Process of Manufacture.

1. (*a*) The steel shall be of the best quality and made by the acid Bessemer or the basic open-hearth (Siemens-Martin) process, as determined by the engineer (or by the purchaser) at the time sale is made.

(*b*) The materials used and the entire process of manufacture and testing shall be in strict accordance with the best standard current practice, and special care shall be taken to conform to the following instructions:

(*c*) The ingots shall be kept in a vertical position in the pit heating furnaces until ready to be rolled, or until the metal in the interior has had time to solidify.

(*d*) No "bled" ingots shall be used, and no ingots from "chilled" heats rolled into first quality rails. A "bled" ingot is one from the center of which liquid steel has escaped. A "chilled" heat is one which, because of the cooling of the steel, has to be either pricked or poured over the top of the ladle.

(*e*) Sufficient material shall be discarded or "cropped" from the top of all ingots, to obtain sound rails.

(*f*) The ingots or blooms must be evenly heated throughout their length, drawn at a uniform temperature, and a uniform finishing temperature also maintained.

Chemical Composition.

2. Rails of the various weights per yard specified below shall conform to the following limits in chemical composition:

BESSEMER STEEL.

	45 to 60 lbs., per cent.	61 to 70 lbs., per cent.	71 to 80 lbs., per cent.	81 to 90 lbs., per cent.	91 to 100 lbs., per cent.
Carbon....	0.30 to 0.40	0.35 to 0.45	0.35 to 0.45	0.40 to 0.50	0.40 to 0.50
Manganese.	0.70 to 1.00	0.70 to 1.00	0.70 to 1.00	0.80 to 1.10	0.80 to 1.10
Silicon....	Not over 0.20	Not over 0.20	Not over 0.20	Not over 0.20	Not over 0.20
Phosphorus	Not over 0.10	Not over 0.10	Not over 0.10	Not over 0.10	Not over 0.10

OPEN-HEARTH STEEL.

	45 to 60 lbs., per cent.	61 to 70 lbs., per cent.	71 to 80 lbs., per cent.	81 to 90 lbs., per cent.	91 to 100 lbs., per cent.
Carbon....	0.40 to 0.55	0.40 to 0.55	0.45 to 0.60	0.55 to 0.70	0.55 to 0.70
Manganese.	0.60 to 0.90	0.60 to 0.90	0.60 to 0.90	0.60 to 0.90	0.60 to 0.90
Silicon....	Not over 0.20	Not over 0.20	Not over 0.20	Not over 0.20	Not over 0.20
Phosphorus	Not over 0.04	Not over 0.04	Not over 0.04	Not over 0.04	Not over 0.04

Chemical Analyses.

3. The manufacturer shall make and furnish to the representative of the engineer (or of the purchaser), before the rails rolled on each turn are ready for shipment, determination of carbon on each heat of Bessemer steel, and average determinations of manganese, phosphorus and silicon representing each twelve-hour rolling; all said analyses to be made on drillings from a test ingot cast when teeming each heat, the drillings being taken at a distance of not less than $\frac{1}{4}$ in. beneath the surface of the said test ingot. If requested by the inspector, the manufacturer shall furnish a portion of the test ingot drillings for check analyses. For open-hearth steel, the manufacturers shall furnish a complete analysis for each heat of steel covering the elements specified in Section 2 hereof.

Impact Test.

4. From every heat of steel a test piece of rail from 4 to 6 ft. long shall be cut at the hot saws, and shall be distinctly marked with the heat number and set aside to cool. As soon as cooled, it shall be placed, head upwards, on the supports of the standard American rail drop-testing machine, described below, and the various sections must withstand, without fracture, one blow of the 2000-lb. tup, from the height specified in the following schedule:

Weight of Rail, lbs. per yd.	Height of Drop, ft.
45	13
50 to 60	14
61 to 70	15
71 to 80	16
81 to 90	17
91 to 100	18

If any rail breaks when subjected to the drop test, two additional tests shall be made of other rails from the same heat of steel, and if either of these latter tests fail, all the rails of the heat which they represent will be rejected; but if both of these additional test pieces meet the requirements, all the rails of the heat which they represent will be accepted.

The report of drop test shall state the atmospheric temperature at the time the test was made. The temperature of the test pieces, when tested, shall be not less than 60° F., nor greater than 120° F. The testing shall proceed concurrently with the operation of the mill.

The drop-testing machine shall conform essentially to the plans and specifications approved by the American Railway Engineering and Maintenance of Way Association. It shall have a freely falling tup of 2000 lbs. weight, the striking face of which shall have a radius of not more than 5 ins. The anvil block shall be a solid casting, weighing, with the attachments that move with it, at least 20,000 lbs. The supports, spaced 3 ft. center to center, and having an upper cylindrical bearing surface with a radius of 5 ins., shall be part of or firmly secured to the anvil.

The leads shall be firmly connected to the base plate and well braced; and provided with a properly divided and plainly marked gage. The tup shall have a tripping head arranged to allow the tongs to release automatically at the exact height for which the tripping device is set and that will also be safe from accidental release while the test piece is being shifted.

5. A piece of rail 6 ft. long taken as a part of a lot of each 100 tons, placed head upwards on supports spaced 3 ft. center to center, must withstand without permanent set the dead weight test as per schedule below: **Dead Weight Test.**

DEAD WEIGHT TEST.

Section of Rail. Height, ins.	Nominal Weight, lbs. per yd.	Load, without Permanent Set, lbs.	Time, minutes.
$3\frac{1}{16}$	45	20,000	5
$3\frac{1}{4}$ to $4\frac{1}{16}$	50–60	25,000	5
$4\frac{7}{16}$ to $4\frac{9}{16}$	65–70	32,000	5
$4\frac{13}{16}$ to 5	75–80	40,000	5
$5\frac{3}{16}$ to $5\frac{3}{8}$	85–90	45,000	5
$5\frac{9}{16}$ to $5\frac{1}{4}$	95–100	50,000	5

If any rail fails when subjected to the dead weight test, two additional tests shall be made of other rails from the same lot, and if either of these latter tests fail, all of the rails of the lot which they represent will be rejected; but if both these additional test pieces meet these requirements, all the rails of the lot which they represent will be accepted.

Section. 6. Before the general manufacture of the rails is commenced, the manufacturer shall, if required by the engineer (or by the purchaser), supply two sets of templets, internal and external, made of approved material. These templets engraved as specified in the contract, shall be submitted to the engineer (or to the purchaser) for his approval, and at the commencement of rolling the engineer shall have a competent person present to approve of the section.

The rails shall be of uniform section throughout, and shall conform, as accurately as possible, to the approved templet, consistent with Section 7 relative to specified weight. To allow for the unavoidable wear of the rolls, a variation in height of $\frac{1}{64}$ in. under and $\frac{1}{32}$ in. over, and in width of base of $\frac{1}{16}$ in. shall be permitted. A perfect fit of the splice bars, however, shall be maintained at all times.

Weight. 7. The weight of the rails shall be maintained as nearly as possible, after complying with Section 6, to that specified in the contract. A variation of one per cent. for individual carload lots, and of one-half per cent. for an entire order, shall be allowed. The manufacturer shall weigh one rail each hour during the entire rolling. Rails shall be accepted and paid for according to actual track scale weight.

Length. 8. Unless otherwise specified in the contract, the standard length of rails shall be 30 ft. Ten per cent. of the entire order, if made, shall be accepted in shorter lengths, varying by 1 ft. down to but not more than 9 ft. below the standard length specified.

Unless otherwise specified in the contract, a variation in length of $\frac{1}{4}$ in. from that specified shall be permitted for the standard practice of rails hot-sawed to length. If it is specified in the contract that the length of rails shall be obtained by cold machining, a variation of $\frac{1}{8}$ in. from the length specified shall be permitted.

Drilling. 9. Holes for splice bolts shall be drilled through the web, from

the solid, at each end of the rails and in strict accordance with the drawings of the purchaser. They shall conform accurately to the drawing and dimensions furnished in every respect; shall be clean and square with the web, and shall be left without burrs on either side. Should any of the holes vary from the correct size or position more than $\frac{1}{32}$ in., the rails in question will be liable to rejection.

Branding.

10. The maker's name, initials or other recognized mark, the weight of the rail per yard, and the month and year of manufacture shall be rolled in raised letters on the side of the web.

The heat number shall be plainly stamped on the web of each rail while hot, at a sufficient distance from the end, so that it will not be subsequently covered by the splice bar. Open-hearth rails shall be branded or stamped "O. H." in a similar manner.

Finish.

11. Rails shall be straight in line and surface when finished; the straightening being carefully done while cold; smooth on head, sawed square at ends (variation to be not more than $\frac{1}{32}$ in.), and, prior to shipment, shall have the burr occasioned by the saw-cutting carefully chipped and filed off, particularly under the head and on top of the flanges; the ends must be clean.

No. 1 rails are to be free from injurious defects and flaws of all kinds.

Inspection.

12. The manufacturer shall give the engineer (or the purchaser), or his inspector, if so instructed, a reasonable notice, in writing, before rolling shall be begun, and similar written notices in advance of each resumption of rolling, in case the order is not filled at one continuous rolling. Should the maker fail to give said notice, all rails rolled in the absence of the duly authorized representative may be rejected as part of the contract. The party thus notified shall, in turn, give written notice to the manufacturer of his intentions to be present, or permission to proceed at the time designated by the maker.

Authorized representatives shall have free access to the works of the manufacturer at all times when the contract is being filled, and shall have, free of cost, all reasonable facilities afforded by the maker to satisfy them that the finished rails are furnished in accordance with the terms of these specifications; the inspection shall, therefore, be conducted so as to cause no serious delays in the processes of manufacture.

All tests and inspection shall be made at the place of manufacture, and the engineer, or his representative at the mill, shall be empowered to give the necessary written certificates of acceptance to the manufacturer, in such a manner as not to cause delays in the shipment of inspected rails.

Seconds or No. 2 Rails.

13. Rails which possess any injurious defects, or which, from any other cause, are not suitable for first quality, or No. 1 rails, shall be considered as "seconds" or No. 2 rails.

They shall not have flaws in their heads of more than $\frac{1}{4}$ in., or in the flange of more than $\frac{1}{2}$ in. in depth, and, in the judgment of the inspector, these shall not be so numerous or of such a character as to render them unfit for recognized No. 2 rail uses.

No. 2 rails shall be accepted up to 5 per cent. of the whole order unless otherwise provided in contract.

Designation of No. 2 Rails and Short Lengths of No. 1 Rails.

14. Both ends of all No. 2 rails shall be painted white. Both ends of all short length No. 1 rails shall be painted green.

OFFICERS

OF THE

AMERICAN SOCIETY FOR TESTING MATERIALS.

President,

ROBERT W. HUNT

First Vice-President,
(*Term Expiring in* 1914)
A. W. GIBBS

Second Vice-President,
(*Term Expiring in* 1913)
A. N. TALBOT

Secretary-Treasurer,

EDGAR MARBURG

Office: University of Pennsylvania, Philadelphia, Pa.

MEMBERS OF THE EXECUTIVE COMMITTEE.

(*Term Expiring in* 1913)

W. A. BOSTWICK,
RICHARD MOLDENKE,
C. E. SKINNER,
G. W. THOMPSON.

(*Term Expiring in* 1914)

JOHN B. LOBER,
CHARLES S. CHURCHILL,
A. A. STEVENSON,
S. W. STRATTON.

STANDING COMMITTEES.

Committee on Finance.

JOHN B. LOBER, *Chairman,*

W. A. BOSTWICK,
A. A. STEVENSON.

Committee on Membership.

A. W. GIBBS, *Chairman,*

EDGAR MARBURG,
RICHARD MOLDENKE,

Committee on Publications.

A. N. TALBOT, *Chairman,*

EDGAR MARBURG,
S. W. STRATTON.

RULES GOVERNING THE EXECUTIVE COMMITTEE.

Regular meetings shall be held on the second Tuesday in January, April, July and October. Four members shall constitute a quorum.

At each meeting the Secretary shall report the names of all new members and of members who have resigned during the previous quarter, and shall present a financial statement.

At the January meeting the Secretary shall report the names of all members whose dues are unpaid.

The accounts of the Treasurer shall be duly audited at the middle and close of each fiscal year, and the report of the auditors shall be presented in writing at the July and January meetings.

Special meetings may be held at any time at the call of the President, or upon the written request of four members of the Executive Committee. The notice for such meetings shall be mailed by the Secretary at least one week in advance of the meeting, and the business shall be stated in the notice.

The Secretary shall transmit the net balance to the credit of the International Association on January 1, April 1, and July 1 to that Association within five days from the dates mentioned.

No expenditures shall be made except on vouchers certified to be correct by the Chairman of the Committee on Finance, or a member thereof designated by the Chairman.

LIST OF MEMBERS

OF THE

AMERICAN SOCIETY FOR TESTING MATERIALS.

AFFILIATED WITH THE INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.

Members holding membership also in the International Association for Testing Materials are distinguished thus (*).

Life Members are distinguished thus (†).

Junior Members are distinguished thus (‡).

ELECTED.

ABBOTT, FRANKLIN E. (see *Lackawanna Steel Company*).

1912. ABBOTT, ROBERT R. Metallurgical Engineer, The Peerless Motor Car Company, Cleveland, O.

1912. *ABEL, WILLIAM FLEMING. Sales Manager, Halcomb Steel Company, 1274 Ontario Street, Cleveland, O.

1907. *‡ABRAHAM, HERBERT. Chemist, Standard Paint Company, Bound Brook, N. J.

1906. *ABRAMS, D. A. Assistant, Laboratory of Applied Mechanics, University of Illinois, Urbana, Ill.

ACKER, E. O'C. (see *Bethlehem Steel Company*).

1905. ADAIR, ARTHUR P. Civil Engineer, Suite 241, Sonna Block, Boise, Idaho.

1909. ADAMS, H. C. Vice-President, Westmoreland Coal Company, 224 South Third Street, Philadelphia, Pa.

1911. ADAMS, H. H. Superintendent, Rolling Stock and Shops. Metropolitan Street Railway, 540 West One Hundred and Twenty-second Street, New York, N. Y.

1910. ADDICKS, LAWRENCE. Superintendent, United States Metals Refining Company, Chrome, N. J.

1909. *AERTSEN, GUILLIAEM. With Midvale Steel Company, 611 Phil Ellena Street, Stenton, Philadelphia, Pa.

1904. AIKEN, CHARLES W. Consulting Engineer, 39 Fifty-third Street, Brooklyn, N. Y.

1902. AIKEN, W. A. Inspecting Engineer, Henry S. Spackman Engineering Company, 42 North Sixteenth Street, Philadelphia, Pa.

1902. *AJAX METAL COMPANY. G. H. Clamer, Second Vice-President and Secretary, 46 Richmond Street, Philadelphia, Pa.

ELECTED.

1910. AKIN, THOMAS B. Master Painter, Box 422, New Bedford, Mass.

1912. AKIN, THOMAS R. President, Laclede Steel Company, 405 Merchants Laclede Building, St. Louis, Mo.

ALDRICH, WILLIAM S. (see *Thomas S. Clarkson Memorial School of Technology*).

ALEXANDER, A. S. (see *Newport News Shipbuilding and Dry Dock Company*).

1912. ALEXANDER, D. BASIL W. Pacific Coast Chemist for The Barber Asphalt Paving Company, 1000 Date Street, Los Angeles, Cal.

1910. *ALLAN, ANDREW, JR. Member of firm, A. Allan and Son, 486 Greenwich Street, New York, N. Y.

1903. ALLEN, A. W. Superintendent, Open-Hearth Department, Tennessee Coal, Iron and Railroad Company, 1616 South Fourteenth Avenue, Birmingham, Ala.

ALLEN, FRANCIS B. (see *Hartford Steam Boiler Inspection and Insurance Company*).

1912. *‡ALLEN, HENRY BUTLER. Metallurgical Engineer, United States Customs, 641 Washington Street, New York, N. Y.

1910. *ALLEN, IRVING C. Petroleum Chemist, United States Bureau of Mines, Fortieth and Butler Streets, Pittsburgh, Pa.

1912. ALLENTOWN PORTLAND CEMENT COMPANY, THE. J. W. Fuller, Vice-President and General Manager, Allentown, Pa.

1912. ALUMINATE PATENTS COMPANY. C. L. Conwell, 2211 Chestnut Street, Philadelphia, Pa.

1910. *ALUMINUM CASTINGS COMPANY, THE. O. F. Flumerfelt, Manager, Research Department, Detroit, Mich.

1910. ‡ALVAREZ, ARTHUR C. Instructor in Civil Engineering, University of California, 1909 Dwight Way, Berkeley, Cal.

1905. AMERICAN ASPHALTUM AND RUBBER COMPANY. H. B. Pullar, Manager of Laboratory, Harvester Building, Chicago, Ill.

1903. *AMERICAN BRASS COMPANY. William H. Bassett, Chemist, Waterbury, Conn.

1902. AMERICAN BRIDGE COMPANY. C. W. Bryan, Chief Engineer, 30 Church Street, New York, N. Y.

ELECTED.

1904. *American Bureau of Inspection and Tests. E. B. Wilson, Secretary and Treasurer, 930 Monadnock Block, Chicago, Ill.

1906. American Bureau of Shipping. Joseph E. Borden, Chief Engineer, 66 Beaver Street, New York, N. Y.

1910. American Electric Railway Engineering Association. Norman Litchfield, Secretary-Treasurer, Ninety-eighth Street and Third Avenue, New York, N. Y.

1898. *American Foundrymen's Association. Richard Moldenke, Secretary, Watchung, N. J.

1905. *American Iron and Steel Manufacturing Company. D. G. Scott, Secretary, Lebanon, Pa.

1911. *American Locomotive Company. F. J. Cole, Chief Consulting Engineer, Schenectady, N. Y.

1912. American Society of Engineering Contractors. J. L. Wemlinger, Secretary, 13 Park Row, New York, N. Y.

1900. *American Steel and Wire Company. F. H. Daniels, Chief Engineer, Worcester, Mass.

1906. American Steel Foundries. J. C. Davis, Assistant First Vice-President, Chicago, Ill.

1910. *American Telephone and Telegraph Company, Engineering Department. J. J. Carty, Chief Engineer, 15 Dey Street, New York, N. Y.

1909. American Water Works and Guarantee Company. Herbert F. Barnard, Purchasing Agent, 345 Fourth Avenue, Pittsburgh, Pa.

1906. *Anaconda Copper Mining Company. E. P. Mathewson, Manager, Reduction Works, Anaconda, Mont.

1909. Anderson, Abel O. Mining and Civil Engineer, Iowa State College, Ames, Iowa.

1912. Anderson, David G. Division Engineer, Pennsylvania State Highway Department, Harrisburg, Pa.

1905. *Anderson, Harold Bentley. Mechanical Engineer, The Winton Motor Carriage Company, Cleveland, O.

1910. *Andrews and Company, F. M. Architects. W. N. Elbert, Secretary, Metropolitan Tower, 1 Madison Avenue, New York, N. Y.

1904. Angus, W. F. Vice-President and Managing Director, Canadian Steel Foundries, Limited, Montreal, Canada.

Anthony, Gardner C. (see *Tufts College, Department of Engineering*).

ELECTED.

1906. ANTISELL, FRANK L. Constructing Engineer, Raritan Copper Works, Perth Amboy, N. J.

1911. ARMSTRONG, T. P. Sales Agent, The Rail-Joint Company, 185 Madison Avenue, New York, N. Y.

1909. ARMSTRONG, W. M. Vice President, Corrugated Bar Company, 402 Mutual Life Building, Buffalo, N. Y.

1909. ‡ARNOLD, R. H. Engineer, 245 Park Avenue, W., Mansfield, O.

1910. *‡ARTER, WILLIAM D. Assistant Engineer, New York Central and Hudson River Railroad, 1012 Grand Central Station, New York, N. Y.

1906. ASHBRIDGE, RICHARD I. D. Chief Engineer, New Jersey Short Line Railroad, 605 Land Title Building, Philadelphia, Pa.

1908. ASHBY, E. B. Chief Engineer, Lehigh Valley Railroad Company, 143 Liberty Street, New York, N. Y.

1912. ASTON, JAMES. Instructor in Chemical Engineering, University of Wisconsin, Madison, Wis.

1911. ATWOOD, P. H. Manager, Armstrong Cement Works, Armstrong, Iowa.

1912. *AUEL, CARL B. Director of Standard Processes and Materials, Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.

1912. AUGUSTINE, CHARLES E. Assistant Engineer, Bureau of Mines, Fortieth and Butler Streets, Pittsburgh, Pa.

1910. AUPPERLE, J. A. Metallurgical Engineer, American Rolling Mill Company, Middletown, O.

1908. *‡AUSTILL, H., JR. Bridge Engineer, Mobile and Ohio Railroad Company, Mobile, Ala.

BABCOCK, W. S. (see *Barrett Manufacturing Company*).

1909. *BACKERT, A. O. Engineering Editor, *The Iron Trade Review*, Cleveland, O.

1911. *BACON, C. G., JR. Assistant to President, Forged Steel Wheel Company, Frick Building, Pittsburgh, Pa.

1910. *‡BACON, CHARLES V. Analytical and Consulting Chemist, 136 Liberty Street, New York, N. Y.

1908. BACON, F. T. H. Chief Engineer, Hudson Terminals, 42 Cortlandt Street, New York, N. Y.

1912. BACON, JOHN FAIRBANK. Assistant Executive, Grand Central Station Architect, 70 East Forty-fifth Street, New York, N. Y.

ELECTED.

1908. BAILEY, E. G. Mechanical Engineer, Fuel Testing Company, 220 Devonshire Street, Boston, Mass.

BAILEY, JOHN M. (see *Pittsburg Testing Laboratory*).

BAIN, H. F. (see *State Geological Survey*).

1903. BAKENHUS, R. E. Civil Engineer, United States Navy, Public Works Office, Navy Yard, Boston, Mass.

1909. ‡BAKER, A. A. Assistant Civil Engineer, United States Navy, Building No. 7, United States Navy Yard, New York, N. Y.

BALDWIN, C. C. (see *Standard Underground Cable Company*).

1911. BALDWIN LOCOMOTIVE WORKS. H. V. Wille, Assistant to General Superintendent, 500 North Broad Street, Philadelphia, Pa.

1911. BALKWILL, GEORGE W. Proprietor, Cleveland Steel Casting Company, East Sixty-ninth Street and Hubbard Avenue, Cleveland, O.

1907. BALLENTINE, WILLIAM I. Superintendent, Link-Belt Company, Indianapolis, Ind.

BALLORD, FRED W. (see *The Cleveland Engineering Society*).

1912. ‡BANKS, GEORGE B. Civil Engineer, 603 Gansevoort Street, Little Falls, N. Y.

1904. *BARBER ASPHALT PAVING COMPANY. J. L. Rake, General Agent, Land Title Building, Philadelphia, Pa.

1910. *‡BARBEY, JACOB W. Assistant Chemist, Packard Motor Car Company, 1180 Jos Campan Avenue, Detroit, Mich.

1898. BARBOUR, FRANK A. Civil Engineer, Snow and Barbour, 1121 Tremont Building, Boston, Mass.

BARINGER, F. J. (see *Eagle White Lead Company*).

1909. ‡BARKER, PERRY. Chemical Engineer, 93 Broad Street, Boston, Mass.

1909. *BARKSDALE, H. M. Vice-President, E. I. duPont de Nemours Powder Company, Wilmington, Del.

1910. *BARLOW, WILLIAM EDWARD. Professor of Metallurgy and Metallography, and Dean of Graduate Department, Virginia Polytechnic Institute, Blacksburg, Va.

BARNARD, HERBERT F. (see *American Water Works and Guarantee Company*).

1910. ‡BARNES, H. C. Engineer of Tests, R. D. Nuttall Company, Pittsburgh, Pa.

1905. BARRETT MANUFACTURING COMPANY. W. S. Babcock, 17 Battery Place, New York, N. Y.

ELECTED.

1912. BARRIER, EDWARD A. Chemical Engineer, 31 Milk Street, Boston, Mass.

1908. BARTLETT, HAYWARD AND COMPANY. Founders and Engineers, Baltimore, Md.

1911. *BASSETT, S. H. President and General Manager, Knickerbocker Portland Cement Company, 1 Madison Avenue, New York, N. Y.

BASSETT, WILLIAM H. (see *American Brass Company*).

1903. *BATEMAN, F. W. Civil Engineer, Clinton, Mass.

1908. BATEMAN, T. J. Chief Inspector of Steel, Delaware, Lackawanna and Western Railroad Company, 314 Railroad Building, Hoboken, N. J.

1912. ‡BATES, JOHN T. Assistant Professor of Mechanical Engineering, Iowa State College, Box 942, Ames, Iowa.

1910. *BATES, P. H. Chemist, Bureau of Standards, Fortieth and Butler Streets, Pittsburgh, Pa.

1911. ‡BATT, W. L. Head of Experimental Department, Hess-Bright Manufacturing Company, Twenty-first Street and Fairmount Avenue, Philadelphia, Pa.

1912. BAUM, GEORGE. Member of Firm, Adam Cook's Sons, 708 Washington Street, New York, N. Y.

1910. BAUSCH AND LOMB OPTICAL COMPANY. H. E. Howe, Chemist, Rochester, N. Y.

1907. *BAXTER, FLORUS R. Chief of Testing Laboratory, Vacuum Oil Company, 926 Exchange Street, Rochester, N. Y.

1911. BEACH, WILLIAM N. President, Pennsylvania Cement Company, 29 Broadway, New York, N. Y.

1906. BEALE, A. H. District Manager, American Sheet and Tin Plate Company, Vandergrift, Pa.

1908. BEALE, HORACE A., JR. President, Parkesburg Iron Company, Parkesburg, Pa.

1911. *BEALL, F. F. Factory Manager, Packard Motor Car Company, 222 Putnam Avenue, Detroit, Mich.

1904. BECK, WESLEY J. Superintendent, Electrical Department, American Rolling Mill Company, Middletown, O.

1903. BECKETT, JAMES A. Hoosick Falls, N. Y

1907. BECKSTRAND, E. H. Professor of Mechanical Engineering, University of Utah, Salt Lake City, Utah.

1908. BEEBE, LAURENCE L. Bureau of Standards, Washington, D. C.

BEEGLE, F. N. (see *Union Drawn Steel Company*).

BEGGS, JOHN I. (see *Milwaukee Electric Railway and Light Company*).

ELECTED.

1906. BELDEN, A. W. Bureau of Mines, Fortieth and Butler Streets, Pittsburgh, Pa.

1910. ‡BELL, A. L. Box 218, Wheeling, W. Va.

1907. BENT, H. B. Engineer of Tests, Pennsylvania Steel Company, Steelton, Pa.

1910. ‡BERDON, ALBERT E. Assistant Manager, The Esterline Company, Lafayette, Ind.

1902. *BERGER, BERNT. Civil Engineer, Assistant Engineer to Theodore Cooper, 45 Broadway, New York, N. Y.

1904. *BERGQUIST, J. G. Superintendent, Cement Plant, Illinois Steel Company, Chicago, Ill.

1903. BERRALL, JAMES. Civil Engineer, 305 Hibbs Building, Washington, D. C.

1905. BERRY, H. C. Assistant Professor of Civil Engineering, University of Pennsylvania, Philadelphia, Pa.

1910. BERRY BROTHERS, LIMITED. James S. Stevenson, Vice-President, Detroit, Mich.

BERRYMAN, JOHN B. (see *Crane Company*).

1898. BETHLEHEM STEEL COMPANY. E. O'C. Acker, South Bethlehem, Pa.

BEYNON, D. E. (see *Dunlop Tire and Rubber Goods Company*).

BICKLEY, WALTER S. (see *Penn Steel Castings and Machine Company*).

BIGELOW, EDWARD M. (see *Pennsylvania State Highway Department*).

1911. BINGHAM, L. L. Manager, Cement Products Company, Estherville, Iowa.

1904. BIRD, ROBERT M. Superintendent, Treatment Department, Bethlehem Steel Company, 433 Broadhead Avenue, South Bethlehem, Pa.

BIRD, WILLIAM W. (see *Worcester Polytechnic Institute*).

1905. BIRKINBINE, JOHN. Consulting Engineer, Parkway Building, Philadelphia, Pa.

1906. BISHOP COMPANY, J. W. 109 Foster Street, Worcester, Mass.

1908. BIXBY, A. S. Superintendent, National Malleable Castings Company, Indianapolis, Ind.

1903. *BIXBY, W. H. Brigadier-General, Chief of Engineers, United States Army, 414 Oxford Building, Washington, D. C.

1910. BLAIR, WILL P. Secretary, National Paving Brick Manufacturers' Association, 824 Brotherhood of Locomotive Engineers' Building, Cleveland, O.

ELECTED.

1908. ‡BLAKELEY, ABRAHAM G. Chemist, Philadelphia and Reading Coal and Iron Company, Pottsville, Pa.

1908. *BLANCHARD, ARTHUR HORACE. Consulting Engineer, Professor of Highway Engineering, Columbia University, New York, N. Y.

1905. BLAUVELT, W. H. Consulting Engineer, Semet-Solvay Company, Syracuse, N. Y.

1909. *BLEININGER, A. V. 910 W. Nevada Street, Urbana, Ill.

1902. BLISS, COLLINS P. Professor of Mechanical Engineering and Director of Testing Laboratory, New York University, University Heights, New York, N. Y.

1909. *BLUM, A. C. Secretary and General Sales Agent, Keystone Powder Manufacturing Company, Emporium, Pa.

1910. BLUMGARDT, I. E. Windsor Hotel, Montreal, Canada.

1910. *BOARDMAN, HAROLD S. Dean of the College of Technology and Professor of Civil Engineering, University of Maine, Orono, Me.

1910. BODWELL, H. L. Assistant District Manager, American Sheet and Tin Plate Company, Vandegrift, Pa.

1912. *‡BOGGS, C. R. Chief Chemist, Simplex Electrical Company, 201 Devonshire Street, Boston, Mass.

1905. BOLE, WILLIAM A. Manager of Works, Westinghouse Machine Company, East Pittsburgh, Pa.

1903. *BOLLER, HODGE AND BAIRD. Consulting Engineers, 149 Broadway, New York, N. Y.

1911. BOLLING, RANDOLPH. Chemist, United States Navy Yard, Norfolk, Va.

1902. BONZANO, A. President, Bonzano Rail-Joint Company, 331 South Eighteenth Street, Philadelphia, Pa.

1896. BOOTH, GARRETT AND BLAIR. Engineers and Chemists, 406 Locust Street, Philadelphia, Pa.

BORDEN, JOSEPH E. (see *American Bureau of Shipping*).

BORTON, G. W. (see *Pennsylvania Crusher Company*).

1910. BOSTON ELEVATED RAILWAY COMPANY. Paul Winsor, Chief Engineer, Motive Power and Rolling Stock, 101 Milk Street, Boston, Mass.

1912. BOSTON SOCIETY OF ARCHITECTS. Charles N. Cogswell, Secretary, 1006 Old South Building, Boston, Mass.

1904. *BOSTWICK, W. A. (*Member of Executive Committee*). Vice-President, Orford Copper Company, 43 Exchange Place, New York, N. Y.

ELECTED.

1911. ‡Boughton, Everett W. Assistant Chemist, Bureau of Chemistry, United States Department of Agriculture, Washington, D. C.

1911. *‡Bourg, Joseph N. Metallurgist, Brown-Lipe-Chapin Company, Syracuse, N. Y.

1912. ‡Bovard, Paul F. Cement Chemist, United States Reclamation Service, Berkeley, Cal.

1908. *Bowen, Samuel B. President, Pecora Paint Company, Fourth and Venango Streets, Philadelphia, Pa.

1904. *Bowman, Austin Lord. Consulting Engineer, 165 Broadway, New York, N. Y.

1911. *Bowman, L. H. Special Engineer, Carnegie Steel Company, Carnegie Building, Pittsburgh, Pa.

1912. Boyce, C. F. Assistant to Managing Director, Norton Griffiths Steel Construction Company, Limited, 801 Dominion Trust Building, Vancouver, B. C.

1912. ‡Boyd, Laurence C. Chemist, Laurentide Company, Limited, Grand Mère, P. Q., Canada.

1909. ‡Boyle, James J. Chemical Engineer, Box 293, Ambridge, Pa.

1907. *Boylston, H. M. Instructor in Metallurgy and Metallography, Harvard University, Rotch Building, Cambridge, Mass.

1902. *Boynton, C. W. Inspecting Engineer, Universal Portland Cement Company, Commercial Bank Building. Chicago, Ill.

1907. Boynton, Henry C. Metallurgist, John A. Roebling's Sons Company, Trenton, N. J.

1910. Bradley and Vrooman Company. F. F. Bradley, Chemist, 2629 Dearborn Street, Chicago, Ill.

Bradley, F. F. (see *Bradley and Vrooman Company*).

1909. Brady, William. Chief Chemist and Chemical Engineer, Illinois Steel Company, 7642 Marquette Avenue, Chicago, Ill.

1910. ‡Bragg, C. T. Chemical Engineer, Berry Brothers, Limited, Detroit, Mich.

1909. *Brainard, Owen. Architectural Engineer, 225 Fifth Avenue, New York, N. Y.

1900. *Braine, L. F. Vice-President, The Rail-Joint Company, 29 West Thirty-fourth Street, New York, N. Y.

1906. Brazer, G. Herbert. Civil Engineer, J. R. Worcester and Company, 79 Milk Street, Boston, Mass.

ELECTED.

BRECKENRIDGE, L. P. (see *Sheffield Scientific School Library*).

1904. BREGOWSKY, IVAN M. Metallurgist, Crane Company, 51 Judd Street, Chicago, Ill.

1912. *BRENEMAN, PAUL BRUCE. Professor of Mechanics and Materials of Construction, Pennsylvania State College, State College, Pa.

1910. BRICK, EDWARD G. Manager, Springfield Contractors' Supply Company, Springfield, Mass.

1911. *BRIDGEPORT BRASS COMPANY. Charles Ferry, Metallurgist, Bridgeport, Conn.

1906. *BRIGHT, H. DE H. Manager, Spring Department, Standard Steel Works Company, Morris Building, Philadelphia, Pa.

1899. BROADHURST, W. H. Chemist, Department of Public Works, Municipal Building, Brooklyn, N. Y.

1909. *BROBSTON, JOSEPH. Treasurer, Dexter Portland Cement Company, Nazareth, Pa.

BROOKS, P. C. (see *The Canadian Fairbanks-Morse Company, Limited*).

BROWN, ALEXANDER E. (see *The Brown Hoisting Machinery Company*).

1911. BROWN, ALEXANDER M. General Manager, Zug Iron and Steel Company, Box 1053, Pittsburgh, Pa.

1905. BROWN AND COMPANY, INCORPORATED. Wayne Iron and Steel Works. James Neale, Secretary, Pittsburgh, Pa.

1911. *BROWN AND SHARPE MANUFACTURING COMPANY. Luther D. Burlingame, Providence, R. I.

1908. BROWN, E. Assistant Professor of Applied Mechanics, McGill University, Montreal, Canada.

1911. BROWN, EDWIN H. Hewitt and Brown, Architects, 716 Fourth Avenue, South Minneapolis, Minn.

1906. BROWN HOISTING MACHINERY COMPANY, THE. Alexander E. Brown, Vice-President and General Manager, Cleveland, O.

1904. *BROWN, JOHN G. 5217 Spruce Street, Philadelphia, Pa.

1906. ‡BROWN, RICHARD P. 311 Walnut Street, Philadelphia, Pa.

1908. BROWN UNIVERSITY, DEPARTMENT OF MECHANICAL ENGINEERING. William H. Kenerson, Associate Professor of Mechanical Engineering, Providence, R. I.

1910. BROWNE, FRANK A. Box 218, Wheeling, W. Va.

1912. *BROWNE, VERE. Chief Chemist, Allegheny Steel Company, Brackenridge, Pa.

ELECTED.

1903. *BRUNNER, JOHN. Assistant General Superintendent, North Works, Illinois Steel Company, Chicago, Ill.

BRYAN, C. W. (see *American Bridge Company*).

1911. BRYDON, R. T. Vice President, Wadsworth and Howland Company, 225 North Carpenter Street, Chicago, Ill.

1910. BUCH, N. W. Superintendent, Safety Armorite Conduit Company, West Pittsburgh, Pa.

1909. *BUCK, D. M. Chief Chemist, American Sheet and Tin Plate Company, McKeesport, Pa.

1909. *‡BUCK, LUCIEN. Civil and Consulting Engineer, Canton, N. C.

1905. BUCK, R. S. Sanderson and Porter, Nevada Bank Building, San Francisco, Cal.

1910. BUFFALO, ROCHESTER AND PITTSBURGH RAILWAY COMPANY. H. G. Burnham, Chemist and Engineer of Tests, DuBois, Pa.

1908. *BULL, R. A. General Superintendent, Commonwealth Steel Company, Granite City, Ill.

BULLENS, DENISON K. (see *Carbon Steel Company*).

1908. BULLITT, W. C. Coal Merchant, 131 South Fourth Street, Philadelphia, Pa.

1904. *BUNNELL, F. O. Engineer of Tests, Chicago, Rock Island and Pacific Railway, Chicago, Ill.

1902. BURDETT, F. A. Consulting Engineer, 29 West Thirty-fourth Street, New York, N. Y.

1911. †BUREAU OF CONSTRUCTION AND REPAIR. United States Navy, Design Branch, Navy Department, Washington, D. C.

1911. †BUREAU OF CONSTRUCTION AND REPAIR. United States Navy, Material Branch, Navy Department, Washington, D. C.

1910. BUREAU OF SCIENCE, LIBRARY. Manila, P. I.

1911. †BUREAU OF STEAM ENGINEERING. United States Navy, Naval Experiment Station, Annapolis, Md.

1911. †BUREAU OF STEAM ENGINEERING. United States Navy, Navy Department, Washington, D. C.

1912 ‡BURGAR, FRED A. Civil Engineer, Welland, Ontario, Canada.

1910. *BURGESS AND LONG. Hydraulic and Chemical Engineers, 827 Columbia Savings and Trust Building, Columbus, O.

1910. BURGESS, CHARLES F. Professor of Chemical Engineering, University of Wisconsin, Madison, Wis.

ELECTED.

BURLINGAME, LUTHER D. (see *Brown and Sharpe Manufacturing Company*).

1906. BURNAP, ARTHUR M. 403 Wood Building, 400 Chestnut Street, Philadelphia, Pa.

BURNHAM, H. G. (see *Buffalo, Rochester and Pittsburgh Railway Company*).

1899. *BURR, WILLIAM H. Professor of Civil Engineering, Columbia University, New York, N. Y.

1912. BURRITT, W. W. Sales Manager, Asbestos Protected Metal Company, Beaver Falls, Pa.

1908. *BURROWS, CHARLES W. Assistant Physicist, Bureau of Standards, Washington, D. C.

BURROWS, J. S. (see *Castner, Curran and Bullitt, Inc.*).

1911. BURT, H. J. Chief Engineer, Holabird and Roche, 1618 Monadnock Block, Chicago, Ill.

1908. BUSH, B. F. President, Missouri Pacific Railway Company, and Denver and Rio Grande Railroad Company, St. Louis, Mo.

1906. *BUSH, HAROLD M. Mechanical Engineer, 508 Capitol Trust Building, Columbus, O.

1908. BUSHNELL, FRED N. Mechanical Engineer, 147 Milk Street, Boston, Mass.

1910. BUTLER, GEORGE. Master Painter, 1640 Market Street, Philadelphia, Pa.

1903. *BUZZI, P. D. Jefe del Laboratorio de Obras Publicas, Arsenal, Havana, Cuba.

1912. BYLLESBY AND COMPANY, H. M., LIBRARY. Engineers, Insurance Exchange Building, Chicago, Ill.

CALDWELL, JAMES H. (see *Ludlow Valve Manufacturing Company*).

1911. CALIFORNIA CORRUGATED CULVERT COMPANY. H. W. Force, Secretary and Manager, West Berkeley, Cal.

1912. CALUMET STEEL COMPANY. A. S. Hook, Vice-President and Treasurer, 72 Adams Street, West Chicago, Ill.

1899. *CAMBRIA STEEL COMPANY. George E. Thackray, Structural Engineer, Johnstown, Pa.

1911. *CAMDEN FORGE COMPANY. W. D. Kerlin, Treasurer, Camden, N. J.

1910 CAMP, J. M. Bureau of Instruction, Carnegie Steel Company, Munhall, Pa.

CAMP, W. M. (see *Railway and Engineering Review*).

ELECTED.

1907. ‡Campbell, Charles M. Chemist, The Garford Company, 128 Garvine Avenue, Elyria, O.

1912. Campbell, Harry A. Engineer in Charge of Bureau of Inspection of Public Improvements, 1209 Merchants Exchange Building, San Francisco, Cal.

1908. *Campbell, H. H. Metallurgical Engineer, The Pennsylvania Steel Company, 112 South North Carolina Avenue, Atlantic City, N. J.

1903. *Campbell, William. Associate Professor of Metallography, School of Mines, Columbia University, New York, N. Y.

1911. Campbell Glass and Paint Company. St. Louis, Mo.

1912. Canadian Fairbanks-Morse Company, Limited, The, Manufacturing Department. P. C. Brooks, Vice-President, 1379 West Bloor Street, Toronto, Canada.

1906. Canals, I. A. Civil Engineer, Box 436, San Juan, Porto Rico.

Candee, C. N. (see *The Gutta Percha and Rubber Manufacturing Company*).

1898. *Capp, John A. Engineer, Chief of Testing Laboratory, General Electric Company, Schenectady, N. Y.

1912. *Carbon Steel Company. Denison K. Bullens, Metallurgist, Pittsburgh, Pa.

1910. *Card, W. J. Cement Inspector, United States Reclamation Service, Hazen, Nevada.

Carhart, P. E. (see *Illinois Steel Company*).

1906. Carmody, John M. Inspector, R. W. Hunt and Company, 1121 The Rookery, Chicago, Ill.

1908. Carnahan, R. B., Jr. Second Vice-President, American Rolling Mill Company, Middletown, O.

1910. *Carnegie, Andrew. 2 East Ninety-first Street, New York, N. Y.

1911. *Carnegie Institute, The., Civil Engineering Department of the School of Applied Science. Francis Michael McCullough, Assistant Professor of Materials, Pittsburgh, Pa.

1908 *Carnegie Library. Schenley Park, Pittsburgh, Pa.

1911. Carnegie Library, Pennsylvania State College. E. W. Runkle, Librarian, State College, Pa.

1898. Carnegie Steel Company. C. F. W. Rys, Metallurgical Engineer, Pittsburgh, Pa.

1903. *Carney, F. D. Assistant Superintendent, The Pennsylvania Steel Company, Steelton, Pa.

ELECTED.

CARPENTER, A. W. (see *New York Central and Hudson River Railroad Company, Engineering Department*).

1902. CARPENTER, LOUIS G. Consulting Engineer, 738 Equitable Building, Denver, Col.

1895. *CARPENTER, ROLLA C. Professor of Experimental Engineering, Cornell University, 31 Eddy Street, Ithaca, N. Y.

1903. *†CARPENTER STEEL COMPANY, THE. J. H. Parker, Metallurgist, Reading, Pa.

1907. CARPENTER, WILLIAM M. Vice-President, American Cross-Arm Company, 1706 Heyworth Building, Chicago, Ill.

1912. ‡CARRINGTON, R. H. Civil Engineer, Afton, N. Y.

CARSON, WILLIAM E. (see *National Lime Manufacturers Association*).

1912. CARTER IRON COMPANY. R. A. Carter, President, Pittsburgh, Pa.

CARTER, R. A. (see *Carter Iron Company*).

1903. CARTLIDGE, C. H. Bridge Engineer, Chicago, Burlington and Quincy Railroad Company, 209 Adams Street, Chicago, Ill.

CARTY, J. J. (see *American Telephone and Telegraph Company, Engineering Department*).

1906. CASE SCHOOL OF APPLIED SCIENCE, DEPARTMENT OF CIVIL ENGINEERING. F. H. Neff, Professor of Civil Engineering, Cleveland, O.

1912. ‡CASO, FERDINANDO. Civil Engineer, Manati, Porto Rico.

1912. CASTNER, CURRAN AND BULLITT, INCORPORATED. J. S. Burrows, Fuel Expert, Box 846, Norfolk, Va.

1908. *CATHCART, ROBERT. Specialist on Concrete Coatings, Glidden Varnish Company, Cleveland, O. *For Mail:* 2247 East Ninety-third Street, Cleveland, O.

1912. ‡CATUNA, GEORGE V. Civil Engineer, 1314 Avenue R, Brooklyn, N. Y.

1910. *CEMENTOS HIDALGO, S. A. Manufacturers of Cement, Hidalgo, N. L., Mexico.

1902. *CENTRAL IRON AND STEEL COMPANY. Robert H. Irons, General Superintendent, Harrisburg, Pa.

1911. CHAMBERLAIN, G. D. Chief Chemist, Carnegie Steel Company, Braddock, Pa.

1910. CHAMBERLIN, A. B. Manager, Road Fuel Oil Department, Indian Refining Company, 17 Battery Place, New York, N. Y.

ELECTED.

1905. CHAMPION, E. C. Three Rivers, Mich.

1907. CHANDLER, B. L. Treasurer, Beckwith-Chandler Company, 201 Emmett Street, Newark, N. J.

CHAPMAN, C. M. (see *Westinghouse, Church, Kerr and Company*).

1907. CHARLS, G. H. Assistant Secretary, The American Rolling Mill Company, Middletown, O.

CHASE, F. S. (see *Chase Rolling Mill Company*).

1912. CHASE, MARCH F. General Superintendent, Mineral Paint Zinc Company, DePue, Ill.

CHASE, NATHAN A. (see *Remington Arms and Ammunition Company*).

1912. *CHASE, WARREN D. Treasurer, The Sterling Manufacturing Company, Hartford, Conn.

1912. CHASE ROLLING MILL COMPANY. F. S. Chase, Treasurer, Waterbury, Conn.

1911. CHATBURN, GEORGE R. Head Professor of Applied Mechanics, University of Nebraska, Lincoln, Neb.

1910. ‡CHATER, W. H. Draftsman, Consulting Engineer's Office, Union Pacific Railroad Company, New York, N. Y. *For Mail:* Hotel Hastings, 197 Fulton Street, Brooklyn, N. Y.

1904. CHEESMAN, FRANK P. Cheesman and Elliot, Owners of National Paint Works, 100 William Street, New York, N. Y.

1911. ‡CHERRINGTON, FRANK W. General Manager, Cincinnati Wood Preserving Company, Cincinnati, O.

1909. CHERRY, W. I. General Contractor, 227 South Rhode Island Avenue, Atlantic City, N. J.

1908. CHESTER, M. E. Assistant Manager, The Goodyear Rubber Insulating Company, 105 East One Hundred and Thirty-first Street, New York, N. Y.

CHETWOOD, R. E. (see *Western Union Telegraph Company*).

1911. ‡CHILD, J. LEO. Director, Hancock Brick and Tile Company, Findlay, O.

1910. ‡CHILDS, WILL P. 1219 North Sixth Street, Terre Haute, Ind.

1909. *‡CHILES, G. S. Instructor in Mechanical Engineering, Lehigh University, 138 South New Street, Bethlehem, Pa.

1912. ‡CHISHOLM, C. R. Dry Dock, Isthmian Canal Commission, Cristobal, Canal Zone.

ELECTED.

1907. CHRISTIE, ALEXANDER J. Colby and Christie, Inspecting Engineers, Witherspoon Building, Philadelphia, Pa.

1912. CHURCH, IRVING P. Professor of Applied Mechanics and Hydraulics, Cornell University, Ithaca, N. Y.

1910. *CHURCH, JOHN A. Mining Engineer, 15 William Street, New York, N. Y.

1907. CHURCH, SUMNER R. American Coal Products Company, 17 Battery Place, New York, N. Y.

1900. *CHURCHILL, CHARLES S. (*Member of Executive Committee*). Chief Engineer, Norfolk and Western Railway Company, Roanoke, Va.

1909. *CHURCHWARD, ALEXANDER. Consulting Engineer, 30 Church Street, New York, N. Y.

1906. CINCINNATI CHAPTER, AMERICAN INSTITUTE OF ARCHITECTS. A. O. Elzner, Secretary, 608 Johnson Building, Cincinnati, O.

CLAMER, G. H. (see *Ajax Metal Company*).

1911. CLARK, A. T. Superintendent, Rolling Stock and Shops, United Railways and Electric Company, Baltimore, Md.

1910. *CLARK, ALLEN W. Editor, *American Paint and Oil Dealer*, 411 North Tenth Street, St. Louis, Mo.

1907. CLARK, EDWIN. Chief of Bureau of Building Inspection, 317 City Hall, Philadelphia, Pa.

1900. *CLARK, F. H. General Superintendent of Motive Power, Baltimore and Ohio Railroad Company, Baltimore, Md.

CLARK, G. T. (see *Leland Stanford Junior University*).

1910. ‡CLARK, W. T. Mechanical Engineer, Erie Railroad Company, 701 East Market Street, Warren, O.

1905. *CLARKE, D. D. Civil Engineer, Water Board, City Hall, Portland, Ore.

1910. *CLARKE, E. A. S. President, Lackawanna Steel Company, 2 Rector Street, New York, N. Y.

1904. CLARKSON MEMORIAL SCHOOL OF TECHNOLOGY, THOMAS S. William S. Aldrich, Director, Potsdam, N. Y.

1910. ‡CLAY, T. F., JR. Material Inspector, Lake Shore and Michigan Southern Railway, Collinwood, O.

1908. CLEARFIELD CLAY WORKING COMPANY. Manufacturers of Paving Brick. R. S. Winslow, Secretary, Clearfield, Pa.

1905. CLEMENTS, FRANK O. Chemist, National Cash Register Company, Dayton, O.

1905. *CLEVELAND ENGINEERING SOCIETY, THE. Fred W. Ballord, Secretary, 413 Chamber of Commerce Building, Cleveland, O.

ELECTED.

1907. *CLINE, MCGARVEY. Director, Forest Products Laboratory, United States Department of Agriculture, Madison, Wis.

1911. CLUETT, SANFORD C. Vice-President and Secretary, Walter A. Wood Mowing and Reaping Machine Company, Hoosick Falls, N. Y.

1912. COBB, C. W. S. President, Glencoe Lime and Cement Company, 915 Olive Street, St. Louis, Mo.

1909. COBB, ERNEST B. Chemist, Standard Oil Company, 26 Broadway, New York, N. Y.

1905. COE, EDWARD K. Engineer of Highways and Bridges, St. Louis County, 205 Court House, Duluth, Minn.

1909. COE, THEODORE IRVING. Architect, 100 William Street, New York, N. Y.

1911. *COGGESHALL, GEORGE W. Consulting Chemical Engineer, 17 Chestnut Street, Dedham, Mass.

COGSWELL, CHARLES N. (see *Boston Society of Architects*).

1910. *COGSWELL, W. B. Vice-President, Solvay-Process Company, Syracuse, N. Y.

1899. *COLBY, ALBERT LADD. Consulting Engineer, and Iron and Steel Metallurgist, 447 Lehigh Street, South Bethlehem, Pa.

1899. COLBY, J. ALLEN. Colby and Christie, Inspecting Engineer, Witherspoon Building, Philadelphia, Pa.

COLE, F. J. (see *American Locomotive Company*).

1910. COLE, WINTHROP. Mechanical Engineer, Engineering Experiment Station, United States Naval Academy, Annapolis, Md.

1900. *COLORADO FUEL AND IRON COMPANY. J. B. McKennan, Manager, Minnequa Plant, Pueblo, Colo.

1908. COLUMBIA STEEL AND SHAFTING COMPANY. E. L. Parker, General Business Manager, Pittsburgh, Pa.

1909. *COMEY, ARTHUR M. Director, Eastern Laboratory, Drawer 424, Chester, Pa.

1909. COMMONWEALTH-EDISON COMPANY. P. Junkenfeld, Assistant to Second Vice-President, 139 Adams Street, Chicago, Ill.

COMPTON, CHARLES H. (see *University of North Dakota*).

1910. CONARD, W. R. Inspecting Engineer, 322 High Street, Burlington, N. J.

1905. CONDIT, E. A., JR. Sales Representative, The Rail-Joint Company, 2348 Oliver Building, Pittsburgh, Pa.

ELECTED.

1900. CONDRON, T. L. Consulting Engineer, 1442 Monadnock Building, Chicago, Ill.

1904. CONLIN, FREDERICK. President, Samuel L. Moore and Sons, Elizabethport, N. J. *For Mail:* 835 Kensington Avenue, Plainfield, N. J.

1904. *CONRADSON, P. H. Chief Chemist, Galena Signal Oil Company, Franklin, Pa.

1908. CONSOLIDATED GOLD FIELDS OF SOUTH AFRICA, LIMITED. Box 1167, Johannesburg, Transvaal.

1907. CONSOLIDATED GOLD FIELDS OF SOUTH AFRICA, LIMITED, INTELLIGENCE DEPARTMENT. Box 1167, Johannesburg, Transvaal.

1905. CONVERSE, W. A. Directing Chemist, Dearborn Drug and Chemical Works, 227–234 Rialto Building, Chicago, Ill.

1912. ‡CONWELL, BENJAMIN T., JR. Manager, Railroad Department, Ehret Magnesia Manufacturing Company, 1200 Land Title Building, Philadelphia, Pa.

CONWELL, E. L. (see *Aluminate Patents Company*).

1903. COOK, EDGAR S. President, Warwick Iron and Steel Company, Pottstown, Pa.

COOK, HARRY H. (see *The Titanium-Alloy Manufacturing Company*).

1909. COOPER, FRED G. W. United States Naval Station, Honolulu, T. H.

1910. *COOPER, JAMES B. Superintendent, Calumet and Hecla Smelting Works, Hubbell, Mich.

1907. COOPER, WILLIAM A. Superintendent, Schuylkill Iron Works, Alan Wood Iron and Steel Company, Conshohocken, Pa.

1911. CORBETT, WILLEBY T. In charge of Rail Department, United States Steel Products Company, 30 Church Street, New York, N. Y.

1909. CORLISS, W. J. Mechanical Engineer, 119 Hyland Avenue, Jersey City, N. J.

1906. *CORNELL UNIVERSITY LIBRARY. George W. Harris, Librarian, Ithaca, N. Y.

1909. CORP, CHARLES I. Assistant Professor of Mechanical Engineering, University of Kansas, Lawrence, Kan.

1909. *CORSE, W. M. Works Manager, Lumen Bearing Company, Sycamore and New York Central Belt Line, Buffalo, N. Y.

1910. CORSON, CHARLES E. Metallurgist, Railway Steel-Spring Company, 1818 Ligonier Street, Latrobe, Pa.

ELECTED.

1899. *Corthell, E. L. Civil Engineer, North Egremont, Mass.
Coxe, William G. (see *The Harlan and Hollingsworth Corporation*).
1912. Cramp and Sons Ship and Engine Building Company, The William. William A. Dobson, Naval Architect, Philadelphia, Pa.
1908. *Crane Company. Manufacturers of Valves and Fittings. John B. Berryman, Assistant Secretary, Chicago, Ill.
1911. Cratty, John M. Chemist, United States Navy Yard, Philadelphia, Pa.
1906. Crawford, D. F. General Superintendent, Motive Power, Pennsylvania Railroad Lines West, Room 1106, Union Station, Pittsburgh, Pa.
1905. ‡Crawford, Harry C. Inspector, Railway Equipments, 1104 Harrison Building, Philadelphia, Pa.
1909. *Cremer, Fritz. Metallurgist and Chemist, Marshall-Wells Hardware Company, Duluth, Minn.
1907. Crockard, Frank H. Vice-President and General Manager, Tennessee Coal, Iron and Railroad Company, Woodward Building, Birmingham, Ala.
1911. Crocker-Wheeler Company. R. B. Treat, D. C. Designer, Ampere, N. J.
1908. *Crockett, Arthur E. Secretary and General Manager, Standard Chain Company, Pittsburgh, Pa.
1906. *Cromwell, O. C. Mechanical Engineer, Baltimore and Ohio Railroad Company, Mount Clare, Baltimore, Md.
1912. ‡Cromwell, William A. Chemist, Baldwin Locomotive Works, Eddystone, Pa.
1909. *Crosby, W. W. Chief Engineer, Maryland Geological and Economic Survey, Consulting Engineer, Johns Hopkins University, Baltimore, Md.
Crossman, G. (see *Western Electric Company*).
1908. Crowe and Company, F. T. 1105 A Street, Tacoma, Wash.
1904. *Crowell, Benedict. Mining Engineer, 731 Williamson Building, Cleveland, O.
1911. ‡Crum, R. W. Assistant Professor of Civil Engineering, Iowa State College, Ames, Iowa.
1904. *Cummings, Robert A. Consulting and Contracting Engineer, Box 659, Pittsburgh, Pa.
1910. *Cuntz, William C. General Manager and Treasurer, Goldschmidt-Thermit Company, 90 West Street, New York, N. Y.

ELECTED.

1912. CURFMAN, L. E. City Engineer, 310 West Rose Avenue, Pittsburg, Kansas.

1906. *CUSHING, W. C. Chief Engineer, Maintenance of Way, Pennsylvania Lines, Southwest System, Union Station, Pittsburgh, Pa.

1904. *CUSHMAN, ALLERTON S. Director, The Institute of Industrial Research, Nineteenth and B Streets, N. W., Washington, D. C.

1912. CUTLER, D. A. Manager, Development Department, Rubber Goods Manufacturing Company, 42 Broadway, New York, N. Y.

1908. DALLAS, JOHN. Inspecting Engineer, 4910 North Twelfth Street, Philadelphia, Pa.

1906. DAMON, GEORGE A. Engineer, with Bion J. Arnold, Los Angeles, Throop Polytechnic Institute, Pasadena, Cal.

DANIELS, F. H. (see *American Steel and Wire Company*).

1912. DANNERTH, FREDERIC. Consulting Industrial Chemist, 180 Bloomfield Avenue, Passaic, N. J.

DARKE, J. M. (see *General Electric Company, Lynn Works*).

1900. *DAVIDSON, GEORGE M. Engineer of Tests, Chicago and Northwestern Railroad, Chicago, Ill.

1907. DAVIES, GEORGE C. Pilling and Crane, 1410 Real Estate Trust Building, Philadelphia, Pa.

1910. DAVIES, J. VIPOND. Vice-President, Jacobs and Davies, Incorporated, 30 Church Street, New York, N. Y.

1904. *DAVIS, CHANDLER. Civil Engineer, Room 116, 1 Broadway, New York, N. Y.

1905. DAVIS, CHARLES HENRY. 18 Old Slip, New York, N. Y.

1910. *‡DAVIS, EUGENE T. 117 Trowbridge Street, Cambridge, Mass.

DAVIS, F. W., JR. (see *Detroit Graphite Company*).

1912. DAVIS, J. A. Second Vice-President, R. C. Hoffman and Company, 1303 Continental Building, Baltimore, Md.

DAVIS, J. C. (see *American Steel Foundries*).

1904. DAVIS, NATHAN H. President, Davis Solid Truss Brake Beam Company, Wilmington, Del.

1908. ‡DAVIS, ROLAND P. Associate Professor of Structural Engineering, Mechanical Hall, West Virginia University, Morgantown, W. Va.

ELECTED.

1912. *DAVIS, SIDNEY L. Inspector, Isthmian Canal Commission, Box 218, Wheeling, W. Va.

DAVIS, WALTER S. (see *The A. Wilhelm Company*).

1903. *DAVIS, WILLIAM R. Chief Bridge Designer, State Engineer's Office, Albany, N. Y.

1899. *DEANS, JOHN STERLING. Chief Engineer, Phœnix Bridge Company, Phœnixville, Pa.

1910. DE BERTODANO, JUAN L. Lieutenant-Commander Engineer, Argentine Navy, care of New York Shipbuilding Company, Camden, N. J.

1906. *DECEW, J. A. Consulting Chemical Engineer, Sun Life Building, Montreal, Canada.

1911. DEEDS, EDWARD A. Second Vice-President, The National Cash Register Company, Dayton, O.

1905. *DEKNIGHT, EDWARD W. President and Manager, Hydrex Felt and Engineering Company, 120 Liberty Street, New York, N. Y.

1912. *DEMOREST, D. J. Assistant Professor of Metallurgy, Ohio State University, Columbus, O.

1912. DENNY-RENTON CLAY AND COAL COMPANY. J. R. Miller, Manager, 1007 Hoge Building, Seattle, Wash.

1912. ‡DE RHODES, GUY L. Civil Engineer, 99 Adams Street, Pueblo, Col.

1902. *DERLETH, CHARLES, JR. Professor of Structural Engineering, University of California, Berkeley, Cal.

1912. *‡DERRY, ARTHUR T. Box 517, Oak Bluffs, Mass.

1904. *DETROIT GRAPHITE COMPANY. F. W. Davis, Jr., Second Vice-President, 141 Broadway, New York, N. Y.

1911. DETROIT TESTING LABORATORY, THE. 1111 Union Trust Building, Detroit, Mich.

1903. DEVERELL, H. F. Secretary, Otis Steel Company, Cleveland, O.

1909. DEVOE AND C. T. RAYNOLDS COMPANY, F. W. Manufacturers of Paints, Varnishes, etc. Represented by Roland Molineaux, 101 Fulton Street, New York, N. Y.

1912. DEVRIES, RALPH P. Assistant Physicist, Bureau of Standards, Washington, D. C.

1908. DEWAR, JOHN. Master Painter, 850 North Avenue, North Side, Pittsburgh, Pa.

ELECTED.

1911. *‡DEWEY, BRADLEY. Chief of Research Laboratory, American Sheet and Tin Plate Company, Pittsburgh, Pa.

1904. DE WYRALL, CYRIL. Chief Inspector, Interborough Rapid Transit Company, New York City. *For Mail:* Ridgefield Park, N. J.

1911. DICKEY, WALTER S. Proprietor, W. S. Dickey Clay Manufacturing Company, Kansas City, Mo.

1911. *DICKINSON, H. C. Associate Physicist, Bureau of Standards, Washington, D. C.

DICKINSON, T. G. (see *Marquette Cement Manufacturing Company*).

1911. *DIEKMANN, GEORGE P. Chief Chemist, Northwestern States Portland Cement Company, Mason City, Iowa.

1912. ‡DIKE, JAMES P. Civil Engineer, 5338 Greenwood Avenue, Chicago, Ill.

1907. DILKS, L. C. Contracting Manager, Eastern Steel Company, 60 Broadway, New York, N. Y.

1903. *DILLER, H. E. Metallurgist, Research Laboratory, General Electric Company, Erie, Pa.

1912. *‡DILLON J. T., JR. Secretary, Titusville Forge Company, Titusville, Pa.

1902. DIXON CRUCIBLE COMPANY, JOSEPH. Malcolm MacNaughton, Superintendent, Paint and Lubricating Department, Jersey City, N. J.

1901. *DOBLE, WILLIAM A. President, Abner Doble Company, Seventh and South Streets, San Francisco, Cal.

DOBSON, WILLIAM A. (see *The William Cramp and Sons Ship and Engine Building Company*).

1910. DODGE, DAY AND ZIMMERMAN. Engineers, 608 Chestnut Street, Philadelphia, Pa.

1912. *‡DOERING, WILLIAM H. Chemist, Fels and Company, Seventy-third Street and Woodland Avenue, Philadelphia, Pa.

1907. DOKE, G. E. Assistant Engineer of Tests, Lake Shore and Michigan Southern Railway Company, Collinwood, O.

1904. DOMINION BRIDGE COMPANY. Phelps Johnson, Manager, Montreal, Canada.

1905. *DONOHOE, JOHN P. Vice-President and General Manager, Donohoe Coke Company, Greensburg, Pa.

ELECTED.

1911. *DONOVAN, JOHN J. Supervising Architect, Palmer and Hornbostel, City Hall, Oakland, Cal.

DOOLITTLE, O. S. (see *Semet-Solvay Company*).

1912. ‡DORAN, MAURICE P. Civil Engineer, 159 First Street, Troy, N. Y.

1912. ‡DORE, JOHN E. Civil Engineer, 164½ Division Street, Amsterdam, N. Y.

1907. DOUGHERTY, J. W. Second Vice-President, Crucible Steel Company of America, 1917 Oliver Building, Pittsburgh, Pa.

1910. DOUGLASS, JAMES. President, The Phelps-Douglass Company, 99 John Street, New York, N. Y.

1909. DOUGLASS, W. J. With William Barclay Parsons, 60 Wall Street, New York, N. Y.

1906. DOUTY, D. E. Assistant Physicist, Bureau of Standards, Washington, D. C.

1898. *DOW, ALLAN W. 24 East Twenty-first Street, New York, N. Y.

1910. DOYLE, J. S. Superintendent Car Equipment, Interborough Rapid Transit Company, Ninety-eighth Street and Third Avenue, New York, N. Y.

1909. DRAKE, BRYANT S. Chemical Engineer, 5830 Colby Street, Oakland, Cal.

1910. *DRINKER, HENRY S. President, Lehigh University, South Bethlehem, Pa.

1909. *‡DROWNE, HENRY B. Principal Assistant Engineer with Arthur H. Blanchard, Instructor in Highway Engineering, Columbia University, 210 Hartley Hall, Columbia University, New York ,N. Y.

1904. DUBBS, J. A. President, Globe Asphalt Company, 405 Bakewell Building, Pittsburgh, Pa.

1910. *‡DUBBS, LELAND A. Chemist, Globe Asphalt Company, 312 Tajo Building, Los Angeles, Cal.

1910. *DUCKWORTH-BOYER ENGINEERING AND INSPECTION COMPANY, LIMITED, THE. 171 St. James Street, Montreal, Canada.

1902. DUCOMB, W. C., JR. Engineer, Royersford Foundry and Machine Company, 52 North Fifth Street, Philadelphia, Pa.

1902. *DUDLEY, P. H. Consulting Engineer, Grand Central Station, New York, N. Y.

ELECTED.

1909. DUKES, RICHARD G. Professor of Applied Science, Purdue University, Lafayette, Ind.

1902. DUMARY, L. HENRY. President, The Helderberg Cement Company, 38 State Street, Albany, N. Y.

1902. DUNBAR, W. O. Assistant Engineer, Testing Department, Pennsylvania Railroad Company, Altoona, Pa.

1912. DUNLOP TIRE AND RUBBER GOODS COMPANY. D. E. Beynon, Superintendent, 80 Hogarth Avenue, Toronto, Canada.

1909. DUNN, B. W. Lieutenant-Colonel, Ordnance Department, United States Army, 24 Park Place, New York, N. Y.

1904. DUNN, W. R. Superintendent, Vulcanite Portland Cement Company, Phillipsburg, N. J.

1905. DUNNING, HUBERT. National Lead Company, 100 William Street, New York, N. Y.

1905. EAGLE WHITE LEAD COMPANY. F. J. Baringer, Chemist, Cincinnati, O.

1912. EASBY, M. WARD. Constructing Engineer, 1420 Chestnut Street, Philadelphia, Pa.

1911. *EASTERN HARD FIBRE COMPANY. H. A. Jackson, President, Merrimac, Mass.

1908. *ECKERSLEY, J. O. Assistant Engineer, Department of Bridges, New York City, 4269 White Plains Avenue, New York, N. Y.

1910. *EDDY, HARRISON P. Consulting Engineer, 14 Beacon Street, Boston, Mass.

1910. *EDWARDS, E. T. President and Manager, Vanadium Alloys Steel Company, Latrobe, Pa.

1912. *EDWARDS, LLEWELLYN N. Structural Engineer, Grand Trunk Railway Company, Box 762, Montreal, Can.

1910. EDWARDS, ROBERT S. Inspecting Engineer, Portland Railway Light and Power Company, 426 Railway Exchange, Portland, Ore.

1902. EDWARDS, WARRICK R. Engineer of Bridges, Baltimore and Ohio Railroad Company, Baltimore and Ohio Building, Baltimore, Md.

1905. *EHRENFELD, CHARLES H. Chemist, York Manufacturing Company, York, Pa.

EHRENSBERGER, EMIL (see *Fried Krupp Company*).

EHRMAN, E. H. (see *Standard Screw Company*).

1904. *EIDLITZ, OTTO M. Civil Engineer, 489 Fifth Avenue, New York, N. Y.

ELECTED.

1908. EISENSCHIML, OTTO. Chemist, American Linseed Company, South Chicago, Ill.

ELBERT, W. N. (see *F. M. Andrews and Company*).

1910. ‡ELDER, FLINT C. Metallurgist, American Steel and Wire Company, 5 High Street, Worcester, Mass.

1909. *ELECTRICAL TESTING LABORATORIES. Clayton H. Sharp, Test Officer, Eightieth Street and East End Avenue, New York, N. Y.

1909. *ELLIOTT, ARTHUR H. Consulting Engineer-Chemist, 165 Broadway, New York, N. Y.

1908. *ELLIOTT, GEORGE K. Chief Chemist and Metallurgist, The Lunkenheimer Company, Cincinnati, O.

1909. ELSON, HARRY E. Chemist, Masontown, Pa.

1910. ‡ELWOOD, W. F. Chief Chemist, Keystone Coal and Coke Company, Greensburg, Pa.

1896. *ELY, THEODORE N. Bryn Mawr, Pa.

ELZNER, A. O. (see *Cincinnati Chapter, American Institute of Architects*).

1908. ELZNER AND ANDERSON. Architects. Ingalls Building, Cincinnati, O.

1909. *EMERSON LABORATORY, THE. Analytical and Industrial Chemists. F. W. Farrell, Chemist, 177 State Street, Springfield, Mass.

1908. *EMERY, A. H. Civil Engineer, 288 Main Street, Stamford, Conn.

1911. ‡EMLEY, WARREN E. Assistant Chemist, United States Bureau of Standards, Fortieth and Butler Streets, Pittsburgh, Pa.

1911. ‡EMORY, LLOYD T. Civil Engineer, 1103 Harrison Building, Philadelphia, Pa.

1912. *ENGER, CHARLES J. Inspector of Boilers, Hartford Steam Boiler Inspection and Insurance Company, Commercial Club, Duluth, Minn.

1898. ENGINEERING RECORD. 239 West Thirty-ninth Street, New York, N. Y.

1905. ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA. Elmer K. Hiles, Secretary, 2511 Oliver Building, Pittsburgh, Pa.

1910. ENGLISH CERAMIC SOCIETY, THE. J. W. Mellor, Secretary, County Pottery Laboratory, Stoke-on-Trent, England.

1905. *ENRIGHT, BERNARD. Director, Eastern Testing Laboratories, Allentown National Bank Building, Allentown, Pa.

ELECTED.

1903. *ERLANDSEN, OSCAR. President, Metropolis Engineering Company, 359 Fulton Street, Jamaica, N. Y.

1910. *EUSTIS, W. E. C. Mining and Smelting, 131 State Street, Boston, Mass.

1912. ‡EVANS, G. S. Chemical Engineer, Lenoir Car Works, Lenoir City, Tenn.

1909. EVANS, M. S. Chief Chemist, Bureau of Construction, City of Pittsburgh, Center and Dithridge Streets, Pittsburgh, Pa.

1906. EVANS, R. W. Treasurer, Picher Lead Company, 511 Tacoma Building, Chicago, Ill.

1904. EVANS, S. M. Manager, New York Office, Picher Lead Company, 100 William Street, New York, N. Y.

1905. EWING, W. W. Engineer, Westinghouse, Church, Kerr and Company, Metropolitan Building, Vancouver, B. C.

1904. *FACKENTHAL, B. F., JR. President, Thomas Iron Company, Easton, Pa.

1908. ‡FALK, H. S. Superintendent, The Falk Company, Milwaukee, Wis.

1905. FALK, MYRON S. Consulting Engineer, 30 Church Street, New York, N. Y.

1902. FALKENAU, A. Industrial and Consulting Engineer, 911 Park Avenue, New York, N. Y.

1909. FALKENBURG AND LAUCKS. Analytical Chemists, 95 Yesler Way, Seattle, Wash.

1909. *FARMER, F. M. Engineer, Electrical Testing Laboratories, Eightieth Street and East End Avenue, New York, N. Y.

FARRELL, F. W. (see *The Emerson Laboratory*).

1912. FARRELL, W. E. Vice-President, Treadwell Engineering Company, Easton, Mass.

1910. *FAY, A. G. President, Ætna Powder Company and Miami Powder Company, 143 Dearborn Street, Chicago, Ill.

1902. FAY, HENRY. Professor of Analytical Chemistry, Massachusetts Institute of Technology, Boston, Mass.

1912. FELLOWS, J. W. Boston Woven Hose and Rubber Company, Box 5077, Boston, Mass.

1909. *FENNELL, JAMES T. Supervising Engineer, John Lang Paper Company, Twenty-fourth and Vine Streets, Philadelphia, Pa.

1910. *FERGUSON, D. M. Assistant Chief Engineer, The E-M-F Company, 253 Rosedale Court, Detroit, Mich.

ELECTED.

1907. Ferguson, F. W. Architect, 15 Beacon Street, Boston, Mass.

1909. Ferguson, Lewis R. Civil Engineer, 1526 Land Title Building, Philadelphia, Pa.

Ferguson, David (see *Pierce-Arrow Motor Car Company*).

1909. Fernald, Robert Heywood. Professor of Mechanical Engineering, University of Pennsylvania, Philadelphia, Pa.

Ferry, Charles (see *Bridgeport Brass Company*).

Findley, A. I. (see *The Iron Age*).

1911. *Finley, Dozier. Chemist and Assistant Superintendent, The Paraffine Paint Company, Emeryville, Cal.

1909. *Fireman, Peter. Manufacturing Chemist, Cosmos Club, Washington, D. C.

1910. *Firmstone, F. Blast Furnace Manager, Easton, Pa.

1910. *Fisher, Henry W. Chief Engineer, Standard Underground Cable Company, Perth Amboy, N. J.

1908. Fisher, Thomas. General Superintendent, 1100 Arcade Building, Philadelphia, Pa.

1911. ‡Fisher, William A. General Agent, Atlantic Coast Line Railroad Company, Gainesville, Fla.

1909. Fitch, Harry M. 301 Mission Street, San Francisco, Cal.

1908. *Fitterer, J. C. Professor of Civil and Irrigation Engineering, University of Wyoming, Laramie, Wy.

1903. *Fitz Gerald, Francis A. J. Chemical Engineer, Fitz Gerald and Bennie Laboratories, Niagara Falls, N. Y.

1911. ‡Flagg, Samuel B. Engineer, Bureau of Mines, Fortieth and Butler Streets, Pittsburgh, Pa.

1899. Flagg, Stanley G., Jr. Stanley G. Flagg and Company, Morris Building, Philadelphia, Pa.

1904. *Fleming, Henry S. Consulting Engineer, Room 116, 1 Broadway, New York, N. Y.

1911. Fleming, William R. Chemist, 716 East Tenth Street, Newport, Ky.

Flewellin, H. E. (see *Orford Copper Company*).

1910. Flowers, Arthur S. Sales Manager, Virginia Railway Supply Company, 324 Dickson Building, Norfolk, Va.

Flumerfelt, O. F. (see *The Aluminum Castings Company*).

1908. *‡Flynn, J. H., Jr. President, Lines, Flynn Company, Incorporated, 50 Church Street, New York, N. Y.

1910. *Follansbee Brothers Company. William U. Follansbee, Secretary and Treasurer, Pittsburgh, Pa.

ELECTED.

FOLLANSBEE, WILLIAM U. (see *Follansbee Brothers Company*).

1912. ‡FONDA, WILLIAM V. T. Civil Engineer, 50 State Street, Troy, N. Y.

1907. *FORCE, H. J. Chemist and Engineer of Tests, Delaware, Lackawanna and Western Railroad Company, Scranton, Pa.

FORCE, H. W. (see *California Corrugated Culvert Company*).

1904. FORD, ALLEN P. Metallurgist, Eaton, Cole and Burnham Company, Bridgeport, Conn.

1911. *FORD, WILLIAM H. General Sales Manager, Canada Cement Company, Limited, Montreal, Canada.

1912. FORE RIVER SHIPBUILDING COMPANY. Henry H. Schulze, Quincy, Mass.

1901. FORREST, C. N. Chief Chemist, New York Testing Laboratory, Maurer, N. J.

1909. *FORSTALL, ALFRED E. Consulting Engineer, 84 William Street, New York, N. Y.

1910. *FORSYTH, ROBERT. Consulting Engineer, 1159 The Rookery, Chicago, Ill.

1903. FORSYTH, WILLIAM. Mechanical Engineer, *Railway Age Gazette*, Chicago, Ill.

1910. *FORT, EDWIN J. Chief Engineer of Sewers, Borough of Brooklyn, 215 Montague Street, Brooklyn, N. Y.

1911. *FORTNEY, C. P. Supervisor Machinery Erection, Isthmian Canal Commission, Gatun, Canal Zone.

1912. *FOSS, FREDERICK E. Professor of Civil Engineering, Cooper Union, New York, N. Y.

1912. *FOUCAR, EDOUARD L. President, Foucor, Ray and Simon, 512 Folsom Street, San Francisco, Cal.

1910. *FOUGNER, HERMANN. Civil Engineer, 25 Madison Square, North, New York, N. Y.

1911. *FOWLER, GEORGE L. Associate Editor, *Railway Age Gazette*, 83 Fulton Street, New York, N. Y.

1905. FOX, ADAM H. President, American Equipment Company, Norristown, Pa.

1908. FRANCIS, J. RICHARD. Chemist, Cleveland, Cincinnati, Chicago and St. Louis Railway, Indianapolis, Ind.

1906. FRANK, JEROME W. Chemist, Standard Varnish Works, 29 Broadway, New York, N. Y.

ELECTED.

1912. ‡FRANKFURTER, P. W. Assistant Engineer of Tests, Baldwin Locomotive Works, 230 West Seymour Street, Germantown, Philadelphia, Pa.

1898. *FRANKLIN INSTITUTE. R. B. Owens, Secretary, 15 South Seventh Street, Philadelphia, Pa.

1907. *FRANKLIN MANUFACTURING COMPANY, H. H. 400 South Geddes Street, Syracuse, N. Y.

1912. FRANKLIN STEEL COMPANY. Edward E. Hughes, Vice-President and General Manager, Franklin, Pa.

1905. *FREEMAN, JOHN R. Consulting Engineer, 814 Banigan Building, Providence, R. I.

1903. FRENCH, JAMES B. Bridge Engineer, Room 1276, 50 Church Street, New York, N. Y.

1911. *FRIEND, O. C. 1641 Wisconsin Street, Racine, Wis.

1904. FROEHLING AND ROBERTSON. Analytical Chemists, Chemical and Mining Engineers, 17 South Twelfth Street, Richmond, Va.

1909. FROHMAN, E. D. Secretary, The S. Obermayer Company, Pittsburgh, Pa.

1905. *FRY, LAWFORD H. Technical Representative in Europe of the Baldwin Locomotive Works, 34 Victoria Street, London, S. W., England.

1907. FRYE, ALBERT I. Consulting Engineer, 704 President Street, Brooklyn, N. Y.

1903. *FULLER, ALMON H. Professor of Civil Engineering, Washington University, University Station, Seattle, Wash.

1906. FULLER, CHARLES E. Associate Professor of Mechanical Engineering, Massachusetts Institute of Technology, Boston, Mass.

FULLER, GEORGE F. (see *The Wyman and Gordon Company*).

FULLER, J. W. (see *The Allentown Port and Cement Company*).

1908. FULLER, J. W., JR. General Manager, Lehigh Car Wheel and Axle Works, Catasauqua, Pa.

1904. FULLER, WILLIAM B. Expert Engineer, Mexican Northern Power Company, Limited, Santa Rosalie, Chihuahua, Mexico.

1909. *FULWEILER, W. HERBERT. Department of Tests, United Gas Improvement Company, Room 514, United Gas Improvement Building, Broad and Arch Streets, Philadelphia, Pa.

FURNESS, RADCLYFFE (see *Midvale Steel Company*).

ELECTED.

1910. FURST, E. W. With The Grassilli Chemical Company, 784 Arcade, Cleveland, O.

1908. GADD, CHARLES J. Engineer, American Iron and Steel Manufacturing Company, Lebanon, Pa.

1905. *GAEHR, DAVID. Contracting Engineer, 950 Rockefeller Building, Cleveland, O.

1912. *GAGE, ROBERT B. Chemist, New Jersey Geological Survey and New Jersey State Road Commission, Trenton, N. J.

1909. *GAINES, RICHARD H. Chemist, Board of Water Supply, New York City, 147 Varick Street, New York, N. Y.

1903. GALBRAITH, J. Principal, School of Practical Science, University of Toronto, Toronto, Canada.

1912. ‡GALLOGLY, HARRY P. Civil Engineer, 620 West One Hundred and Thirty-eighth Street, New York, N. Y.

1911. *GANNON, THOMAS J. Engineer in charge of Mechanical Division and Inspection, Department of Water Supply, Gas and Electricity, 13 Park Row, New York, N. Y.

1912. ‡GANSER, J. W. Chief Chemist, Chicago Portland Cement Co., Oglesby, Ill.

1912. *‡GARDNER, E. S. Metallurgical Department, Illinois Steel Company, South Chicago, Ill.

1911. *GARDNER, HARRY. Assistant Professor of Civil Engineering, University of Kansas, Lawrence, Kan.

1908. ‡GARDNER, HENRY A. Assistant Director, The Institute of Industrial Research, Nineteenth and B Streets, N. W., Washington, D. C.

1905. GARFIELD, ALEXANDER STANLEY. Chief Engineer, Cie. Francaise Thomson-Houston; Consulting Engineer, Mediterranean Thomson-Houston Company and General Electric Company. 67 Avenue De Malakoff, Paris, France.

1905. GARLINGHOUSE, F. L. Structural Engineer, Jones and Laughlin Steel Company, Glenshaw, Pa.

1909. *GARRISON, O. L. President, Big Muddy Coal and Iron Company, 912 Wainwright Building, St. Louis, Mo.

GARTLEY, W. H. (see *United Gas Improvement Company*).

1912. ‡GARVIN, BURR K. Civil Engineer, 230 West Ninety-seventh Street, New York, N. Y.

1911. GATES, A. W. Secretary and General Manager, Monmouth Mining and Manufacturing Company, Monmouth, Ill.

ELECTED.

1910. Gayley, James. Manufacturer, 71 Broadway, New York, N. Y.

1907. Geer, William C. Chief Chemist, B. F. Goodrich Company, Akron, O.

1908. General Electric Company. J. A. Capp, Chief of Testing Laboratory, Schenectady, N. Y.

1909. General Electric Company, Lynn Works. J. M. Darke, Chief of Testing Laboratories, West Lynn, Mass.

1911. *General Motors Company. Tracy Lyon, Director of Production, Detroit, Mich.

1909. George, W. H. Secretary, Cowell Portland Cement Company, 95 Market Street, San Francisco, Cal.

1910. Gerety, R. M. Architectural Engineer, Department of Buildings, Chicago, Ill.

1905. *Gerlach, O. Manager, Mobile Portland Cement and Coal Company, St. Stephens, Ala.

1902. *Gerstell, A. F. Vice-President and General Manager, Alpha Portland Cement Company, Alpha, N. J.

1906. *Gibboney, James H. Chief Chemist, Norfolk and Western Railway Company, 414 Thirteenth Avenue, S. W., Roanoke, Va.

1902. Gibbs, A. W. (*First Vice-President*). Chief Mechanical Engineer, Pennsylvania Railroad Company, Broad Street Station, Philadelphia, Pa.

1912. ‡Gibson, F. I. Superintendent, Paint Department, Southern Cotton Oil Company, Savannah, Ga.

1905. Giesler, Arthur. Consulting Engineer, Dayton, O.

1910. ‡Gifford, A. McK. Chemist, General Electric Company, Pittsfield Works, 20 Linden Street, Pittsfield, Mass.

1907. Gilg, Henry F. 1223 Island Avenue, N. S., Pittsburgh, Pa.

1905. *Gill, Augustus H. Assistant Professor of Technical Analysis, Massachusetts Institute of Technology, Boston, Mass.

1912. Gillespie, J. M. Assistant General Manager, Lockhart Iron and Steel Company, Pittsburgh, Pa.

Girl, Christian (see *The Perfection Spring Company*).

1904. *Giroux, Gustave. Inspector of Materials, Canadian Pacific Railway Company, 1101 East Craig Street, Montreal, Canada.

ELECTED.

1904. *GLASGOW IRON COMPANY. C. B. Shoemaker, President, 603-608 Harrison Building, Philadelphia, Pa.

1909. *GLOVER, GEORGE J. General Contractor, 1111 Hibernia Building, New Orleans, La.

1912. ‡GLUECK, FRANK J. Civil Engineer, 2004 Fairmount Avenue, Philadelphia, Pa.

1910. GOETZE, FREDERICK A. Dean of the Schools of Mines, Engineering and Chemistry, Columbia University, New York, N. Y.

1910. *‡GOLDBECK, ALBERT T. Testing Engineer, Office of Public Roads, United States Department of Agriculture, 1626 S Street, Washington, D. C.

GOLDBERG, H. (see *Aluminum Castings Company*).

1910. *GOLDMARK, HENRY. Designing Engineer, Isthmian Canal Commission, Culebra, Canal Zone.

1909. *GOODENOUGH, WALTER. Engineer, Stone and Webster Engineering Corporation, Boston, Mass.

1904. GOODMAN, CARLTON M. Superintendent, Standard Portland Cement Company, Leeds, Ala.

1912. GOODRICH COMPANY, THE B. F. W. C. Geer, Chief Chemist, Akron, O.

1908. *GOODRICH, E. P. Consulting Engineer, 35 Nassau Street, New York, N. Y.

GOODRICH, NATHANIEL L. (see *West Virginia University Library*).

1904. GOODSPEED, G. M. Metallurgist, National Tube Company, McKeesport, Pa.

1910. *GORMULLY, A. R. Contracting Department, United States Motor Company, 896 West End Ave., New York, N. Y.

1910. GOSS, EDWARD O. Assistant Manager, Scovill Manufacturing Company, Waterbury, Conn.

1907. GOSS, OLIVER P. M. Engineer of Timber Tests, United States Forest Service. *For Mail:* Box 112, University Station, Seattle, Wash.

1896. *GOSS, WILLIAM F. M. Dean of the Schools of Engineering, University of Illinois, Urbana, Ill.

GOULD, C. H. (see *McGill University Library*).

1908. GOULD, W. S. President, Fuel Engineering Company of New York, 59 Pearl Street, New York, N. Y.

1908. *GOWIE, WILLIAM. Box 175, Kittanning, Pa.

1911. *‡GRAF, SAMUEL HERMAN. Instructor in Mechanical Engineering, State Agricultural College, Corvallis, Ore.

ELECTED

1911. ‡GRAHAM, WILLIAM E. Inspector, R. W. Hunt and Company, 536 Jackson Street, Gary, Ind.

1911. ‡GRANGER, L. D. Metallurgist, American Steel and Wire Company, 94 Grove Street, Worcester, Mass.

1911 *GRANT, JOHN ROBERT. Consulting Civil Engineer, 503 Cotton Bui ding, Vancouver, B. C.

1912. ‡GRANTEN, SYLVESTER H. Testing Engineer, Isthmian Canal Commission, Culebra, Canal Zone.

GRAY, C. D. (see *J. G. White and Company*).

1909. GRAY, H. W. Assistant Professor of Experimental Civil Engineering, in charge of Structural and Hydraulic Laboratories, Iowa State College, Ames, Ia.

1903. *GRAY, JOHN LATHROP. Assistant Superintendent, Tide-water Oil Company, East Twenty-second St., Bayonne, N. J.

1905. *GRAY, THOMAS TARVIN. Chemist, Tide-water Oil Company, East Twenty-second Street, Bayonne, N. J.

1912. GRAYSON, SYDNEY ALWYN. General Manager, Jessop Steel Company, Washington, Pa.

1910 GREELEY, SAMUEL A. Sanitary Engineer, 822 Opera House Block, Chicago, Ill.

1906. *GREEN, HERBERT. Mechanical Engineer, Peoples Gas Building, Chicago, Ill.

1910. ‡GREENE, E. T. Chemist, Henry S. Spackman Engineering Company, 42 North Sixteenth Street, Philadelphia, Pa.

1905. GREENE, GEORGE W. Inspecting Engineer, American Bureau of Inspection and Tests, 313 Wabash Building, Pittsburgh, Pa.

1912. *‡GREENE, HERMANN L. Chief Chemist, J. H. Williams and Company, 31 Seeley Street, Brooklyn, N. Y.

1904. *GREENMAN, RUSSELL S. Resident Engineer in charge of Tests, Department of State Engineering and Surveying, Albany, N. Y.

1907. *GREGG, NORRIS B. President, Mound City Paint and Color Company, St. Louis, Mo.

1911. GREGORY, ALFRED C. Engineer of Sewers, 555 Rutherford Avenue, Trenton, N. J.

1906. GREGORY, E. D. Vice-President and General Manager, Frazer Paint Company, Bedford City, Va.

1906. GREGORY, JOHN H. Rudolph Hering and John H. Gregory, Consulting Engineers, 170 Broadway, New York, N. Y.

ELECTED.

GREGORY, W. B. (see *Tulane University, Department of Experimental Engineering*).

1902 GREINER, J. E. Consulting Engineer, 1308 Fidelity Building, Baltimore, Md.

1910. GRIFFITH, J. K. 303 Susquehanna Avenue, Pittston, Pa.

1906. GRIFFITH, R. E. Vice-President, American Cement Company, 604 Pennsylvania Building, Philadelphia, Pa.

1906. *GRIFFITHS, T. S. General Manager, Canadian Inspection Company, 204 St. James Street, Montreal, Canada.

1912. *GRISWOLD, H. C. Assistant Inspecting Engineer, Illinois Steel Company, 72 West Adams Street, Chicago, Ill.

1910. GROSE, JAMES H. Superintendent, Howard Axle Works, Carnegie Steel Company, Homestead, Pa.

1909. *GUDEMAN, EDWARD. Chemical Engineer, 903 Postal Telegraph Building, Chicago, Ill.

1907. GULICK, HENRY, JR. Gulick-Henderson Company, 439 Third Avenue, Pittsburgh, Pa.

1912. GUTTA PERCHA AND RUBBER MANUFACTURING COMPANY, THE. C. N. Candee, Secretary and General Manager, 47 Yonge Street, Toronto, Canada.

1908. HAAS, FRANK R. Consulting Engineer, The Consolidation Coal Company, Fairmont, W. Va.

1906. *HADFIELD, R. A. Steel Manufacturer, Hecla Works, Sheffield, England.

1901. HAGAR, EDWARD M. President, Universal Portland Cement Company, Commercial Bank Building, Chicago, Ill.

1910. HAGER, ALBERT B. Secretary, Fidelity Engineering and Inspecting Company, 30 Church Street, New York, N. Y.

1906. *HAINES, JOHN L. Assistant to Vice-President, Jones and Laughlin Steel Company, Pittsburgh, Pa.

1905. *HALDEMAN, HORACE L. Treasurer, Pulaski Iron Company, 1008 Real Estate Trust Building, Philadelphia, Pa.

1910. *HALE, RICHARD KING. Civil Engineer, 85 Water Street, Boston, Mass.

1911. *HALL, CHARLES WARD. Contractor and Engineer, 140 Nassau Street, New York, N. Y.

1910. HALL, CLARENCE. Explosives Engineer, Fortieth and Butler Streets, Pittsburgh, Pa.

ELECTED.

1911. ‡HALL, ELLIS B. Chemist and Engineer of Tests, Cleveland, Cincinnati, Chicago and St. Louis Railroad, 2329 North Capitol Avenue, Indianapolis, Ind.

1910. *HALL, JOHN H. Metallurgist, Taylor Iron and Steel Company, High Bridge, N. J.

1911. ‡HALL, QUINCY A. Testing Engineer, Isthmian Canal Commission, Gorgona, Canal Zone.

HALLINEN, J. E. (see *M. Rumely Company*).

1908. HAMBURGER, SAMUEL. Assistant Engineer, Department of Bridges, City of New York, Park Row Building, New York, N. Y.

1910. *HAMMOND, GEORGE T. Engineer of Design, Bureau of Sewers, Brooklyn, 156 Berkeley Place, Brooklyn, N. Y.

1911. HAMNER, CHARLES S. Mechanical Engineer, 25 Broad Street, New York, N. Y.

1905. *‡HANNA, W. C. Chemist, California Portland Cement Company, Colton, Cal.

1905. HARDING, CHESTER. Captain, Corps of Engineers, United States Army, Gatun, Canal Zone.

1902. HARDING, W. H. President, Whitehall Cement Manufacturing Company, 1722 Land Title Building, Philadelphia, Pa.

1903. *HARGROVE, JULIAN O. Inspector of Asphalt and Cements, 1603 O Street, N. W., Washington, D. C.

1912. HARLAN AND HOLLINGSWORTH CORPORATION, THE. William G. Coxe, President, Wilmington, Del.

1902. *HARRIMAN, N. F. Chemist and Engineer of Tests, Union Pacific Railroad, Omaha, Neb.

HARRIS, GEORGE W. (see *Cornell University Library*).

1908. *HARRIS, J. R. Chief Chemist, T. C. I. & R. R. Co., Box 731, Birmingham, Ala.

1910. *HARRISON, P. B. General Superintendent, Chicago Railway Equipment Company, Forty-sixth Street and Winchester Avenue, Chicago, Ill.

1912. HART, O. C. Chemist, Portland Cement Company, Salt Lake City, Utah.

1902. *HARTFORD STEAM BOILER INSPECTION AND INSURANCE COMPANY. Francis B. Allen, Vice-President, Hartford, Conn.

ELECTED.

1904. HARTLEY, HENRY J. Superintendent, Boiler Department, William Cramp and Sons Ship and Engine Building Company, 1624 Oxford Street, Philadelphia, Pa.

1898. HARTRANFT CEMENT COMPANY, WILLIAM G. Sole Selling Agent for Old Dominion and Phœnix Portland Cement, Real Estate Trust Building, Philadelphia, Pa.

1905. *HARVARD COLLEGE LIBRARY. Alfred C. Potter, Assistant Librarian, Cambridge, Mass.

1911. HARVIE, WILLIAM J. Railway Manager, J. G. White and Company, 43 Exchange Place, New York, N. Y.

1912. HASKELL, EUGENE E. Director, College of Civil Engineering, Cornell University, Ithaca, N. Y.

1911. *HASTINGS, CHARLES L. General Sales Manager, Vanadium Sales Company of America, 324 Frick Building, Pittsburgh, Pa.

1898. *HATT, WILLIAM K. Professor of Applied Mechanics, Purdue University, Lafayette, Ind.

1910. ‡HAVENS, WILLIAM W. Assistant Engineer, Public Service Commission for the First District, State of New York, 469 East One Hundred and Thirty fourth Street, New York, N. Y.

1904. *HAWXHURST, ROBERT, JR. Consulting Engineer, 36 Bishopsgate, London, E. C., England.

1909. HAY, J. T. Chief Chemist, The Stark Rolling Mill Company, Canton, O.

1906. HAYES, J. ARTHUR. Resident Manager, United States Cast Iron Pipe and Foundry Company, Burlington, N. J.

1907. HAYWARD, HENRY E. Engineer of Tests, Link-Belt Company, Nicetown, Philadelphia, Pa.

1906. HAYWARD, H. W. Instructor, Mechanical Engineering, Massachusetts Institute of Technology, Boston, Mass.

1907. HAZEN, WILLIAM NELSON. Engineer, Expanded Metal Engineering Company, Union Building, Newark, N. J.

1906. HEALD, E. C. J. Henry Miller, Incorporated, 106 Dover Street, Baltimore, Md.

1903. HEARNE, W. W. Member of firm Mathew Addy and Company, 411 Real Estate Trust Building, Philadelphia, Pa.

1912. *HEATH, FRANK C. Mechanical Engineer, Schaum and Uhlinger, 4045 North Twelfth Street, Philadelphia, Pa.

1910. *HEATH, GEORGE L. Chemist, Calumet and Hecla Smelting Works, Hubbell, Mich.

ELECTED.

1905. Heckel, G. B. Editor, *Drugs, Oils and Paints*, 634-36 The Bourse, Philadelphia, Pa.

1904. Heidenreich, E. Lee. Chief Engineer, Builders' Material Supp y Company, Scarritt Building, Kansas City, Mo.

1910. Heinrich, E. O. City Chemist, 3214 North Thirtieth Street, Tacoma, Wash.

1910. ‡Heizmann, L. J. Mechanical Engineer, Penn Hardware Company, 318 North Fifth Street, Reading, Pa.

1909. Heller and Wilson. Consulting Engineers, First National Bank Building, San Francisco, Cal.

1904. *Helwig, Alfred. Engineer, Edison Electric Illuminating Company, 360 Pearl Street, Brooklyn, N. Y.

1904. *Hemstreet, George P. Superintendent, Hastings Pavement Company, Hastings-upon-Hudson, N. Y.

Hendee, Edward T. (see *Joseph T. Ryerson and Son*).

Henderson, Eliah (see *Manhattan Rubber Manufacturing Company*).

1910. Hendricks, A. B., Jr. Engineer of Materials, General Electric Company, Pittsfield Works, 212 East Street, Pittsfield, Mass.

Henry, A. S. (see *Railway Steel Spring Company*).

1911. *Henry, John A. Chief Inspector, Homestead Steel Works, Carnegie Steel Company, Munhall, Pa.

1903. Henshaw, John O. Member, N. S. Bartlett and Company, 126 State Street, Boston, Mass.

Hepburn, W. M. (see *Purdue University Library*).

1909. Heppinstall, C. W. Secretary and Treasurer, Heppinstall Forge and Knife Company, Forty-seventh Street and Allegheny Valley Railway, Pittsburgh, Pa.

1904. *Hering, Rudolph. Hydraulic and Sanitary Engineer, 170 Broadway, New York, N. Y.

1911. Herman, Bernard. Chief Engineer, Maintenance of Way and Shops, Southern Railway, Washington, D. C.

1910. ‡Hermann, Charles E. Assistant to President, Moose Mountain, Limited, 111 Broadway, New York, N. Y.

1911. *‡Hermann, George E. Inspector, R. W. Hunt and Company, 309 White Building, Seattle, Wash.

1910. *Herreshoff, James B., Jr. Superintendent, Nichols Copper Company, Laurel Hill, N. Y.

1911. *Herron, James H. Consulting Engineer and Metallurgist, Engineers' Building, Cleveland, O.

ELECTED.

1906. *HERSEY, MILTON L. City and Provincial Analyst, 171 St. James Street, Montreal, Canada.

1912. *HESS, HENRY. President, Hess-Bright Manufacturing Company and Hess Steel Castings Company, 1510 Allegheny Avenue, Philadelphia, Pa.

1910. HEWITT, THOMAS E. Assistant Chemist, American Sheet and Tin Plate Company, 331 Atwood Street, Pittsburgh, Pa.

1910. HEYL AND PATTERSON, INCORPORATED. W. J. Patterson, President, 50 Water Street, Pittsburgh, Pa.

1910. *HIBBARD, HENRY D. Consulting Engineer, 144 East Seventh Street, Plainfield, N. J.

1911. HIBBS, MANTON E. Structural Engineer, Bureau of Building Inspection, 317 City Hall, Philadelphia, Pa.

1912. ‡HIGGINS, WILTON A. Wire Mill Superintendent, Northern Aluminum Company, Limited, Shawinigan Falls, P. Q., Canada.

1902. HILDRETH, P. S. Consulting and Inspecting Engineer, 135 Broadway, New York, N. Y.

HILES, ELMER K. (see *Engineers' Society of Western Pennsylvania*).

1910. HILL, C. D. Engineer, Board of Local Improvements, City Hall, Chicago, Ill.

1911. HILL, HALBERT P. Engineer, 30 Church Street, New York, N. Y.

1909. HILL, NICHOLAS S., JR. Consulting Engineer, 100 William Street, New York, N. Y.

1909. HILLEBRAND, W. F. Chief Chemist, Bureau of Standards, Washington, D. C.

1909. *HILLES, RAYMOND W. Sales Manager, S. H. French and Company, York Avenue, Fourth and Callowhill Streets, Philadelphia, Pa.

1912. ‡HINRICHS, ADOLPH. Civil Engineer, 179 Lewis Avenue, Brooklyn, N. Y.

HITCHCOCK, LAWRENCE. (see *Kelley Island Lime and Transportation Company*).

1912. ‡HOAR, JOHN C. Civil Engineer, 21 St. Mary's Avenue, Troy, N. Y.

1911. HOCKSTETTER, ROBERT. Vice-President, The Ault and Wiborg Company, Cincinnati, O.

1910. HODGES, HARRISON B. Purchasing Agent, Long Island Railroad Company, Pennsylvania Station, Seventh Avenue and Thirty-third Street, New York, N. Y.

ELECTED.

1904. *Hoff, Olaf. Consulting Engineer, 149 Broadway, New York, N. Y.

1907. ‡Hoffhine, John. First Assistant Chemist, Union Pacific Railroad Company, Omaha, Neb.

1912. *Hofman, G. Max. President, National Steel Casting Company, 1118 Calhoun Street, Fort Wayne, Ind.

1907. *Hogue, Chester J. Constructing Engineer, The Concrete Engineering Company, Room 1104, 141 Milk Street, Boston, Mass.

1912. *‡Hohl, Leonard Louis. Inspector of Materials, Bureau of Inspection, 1209 Merchants Exchange, San Francisco, Cal.

1906. ‡Holmes, Addison F. Instructor, Mechanical Engineering, Massachusetts Institute of Technology, Boston, Mass.

1903. Holmes, Joseph A. Director, Bureau of Mines, Washington, D. C.

1907. *Holst, J. L. Engineer of Structures, New York Central and Hudson River Railroad, Room 5625, 70 East Forty-fifth Street, New York, N. Y.

Hook, A. S. (see *Calamut Steel Company*).

1906. *Hooker, A. H. Hooker Electrochemical Company, Niagara Falls, N. Y.

1911. Hoover, W. C. Secretary-Treasurer and Manager, Portland Drain Tile Company, Portland, Ind.

1911. *Hopkins, George A. Metallurgist, Carnegie Steel Company, Munhall, Pa.

1910. Horn, A. C. Waterproofing Contractor, 8–10 Burling Slip, New York, N. Y.

Horne, H. J. (see *John A. Roebling's Sons Company*).

1908. *Hovey, O. E. Assistant Chief Engineer, American Bridge Company of New York, Hudson Terminal, 30 Church Street, New York, N. Y.

1906. Howard, James E. Engineer-Physicist, Bureau of Standards, Washington, D. C.

1909. Howard, James W. Consulting Engineer, 1 Broadway, New York, N. Y.

1903. Howard, L. E. 215 Niagara Street, Lockport, N. Y.

1909. *Howard, O. Zell. Mechanical Engineer, 356 West One Hundred and Forty-fifth Street, New York, N. Y.

Howe, H. E. (see *Bausch and Lomb Optical Company*).

ELECTED.

1896. *HOWE, HENRY M. Professor of Metallurgy, Columbia University, Broad Brook Road, Bedford Hills, N. Y.

1909. HOWE, MALVERD A. Professor of Civil Engineering, Rose Polytechnic Institute, 2108 North Tenth Street, Terre Haute, Ind.

1912. *HOWELL, S. A. Engineer of Tests, Heller Brothers Company, Newark, N. J. *For Mail:* 354 Livingston Street, Elizabeth, N. J.

1910. HOWELL, SPENCER P. Assistant Engineer, Bureau of Mines, Fortieth and Butler Streets, Pittsburgh, Pa.

1909. HOXIE, FREDERICK J. Engineer and Special Inspector, Mutual Fire Insurance Company's Factory, Phenix, R. I.

1905. *HOYT METAL COMPANY. J. Clarence McGrew, Engineer of Tests, St. Louis, Mo.

1912. *HOYT, ROBERT O. Engineer, United States Reclamation Service, Box 551, Helena, Mont.

1908. *HUBBARD, PRÉVOST. Chief, Division of Roads and Pavements, The Institute of Industrial Research, Nineteenth and B Streets, N. W., Washington, D. C.

1904. *HUBBELL, C. A. President, R. Almond Manufacturing Company, Ashburnham, Mass.

1904. HUBER, FREDERICK W. Consulting Chemical Engineer, 633 Title Insurance Building, Los Angeles, Cal.

1905. HUGHES AND PATTERSON. Manufacturers of Bar Iron, 800 Richmond Street, Philadelphia, Pa.

HUGHES, EDWARD E. (see *Franklin Steel Company*).

1905. *HUGHES, HECTOR J. Assistant Professor of Hydraulics and Sanitary Engineering, Harvard University, 114 Pierce Hall, Cambridge, Mass.

HUGHES, JAMES L. (see *Worth Brothers Company*).

1907. HUGHES, L. S. Chief Chemist, Picher Lead Company, Tacoma Building, Chicago, Ill.

1904. HUME, A. P. Engineer of Tests, American Bridge Company, Pencoyd, Pa.

1896. *HUMPHREY, RICHARD L. Consulting Engineer and Chemist, 805 Harrison Building, Philadelphia, Pa.

1903. HUNNINGS, S. V. Chemist and Engineer of Tests, American Locomotive Company, Schenectady, N. Y.

1903. *HUNT, LOREN E. Bureau of Engineering, Department of Public Works, San Francisco, Cal. *For Mail:* 2639 Filbert Street, San Francisco, Cal.

ELECTED.

1899. *Hunt and Company, Robert W. Inspecting and Testing Engineers. Robert W. Hunt (*President*). 1121 The Rookery, Chicago, Ill.

1907. *Hunt Company, Limited, Robert W. T. C. Irving, Jr., Vice-President, Traders' Bank Building, Toronto, Canada.

1911. *‡Huntington, W. C. Advanced Student, Königliche Technische Hochschule, Aachen. *For Mail:* Care of C. W. Huntington, General Superintendent, Central Railroad of New Jersey, 143 Liberty Street, New York, N. Y.

Huston, Charles L. (see *Lukens Iron and Steel Company*).

1910. Hutchins, H. C. Secretary, Ajax Forge Company, Hoyne Street and Blue Island Avenue, Chicago, Ill.

1906. Hutchinson, Cary T. Consulting Engineer, 60 Wall Street, New York, N. Y.

1905. Hyde, A. Lincoln. Assistant Professor of Bridge Engineering, University of Missouri, Columbia, Mo.

1903. Hyde, Charles G. Assistant Professor of Sanitary Engineering, University of California, Berkeley, Cal.

1906. Ickes, Elwood T. Inspector, Carnegie Steel Company, Room 522, Carnegie Building, Pittsburgh, Pa.

1904. *Illinois Central Railroad Company. W. L. Park, Vice-President and General Manager, Commercial National Bank Building, Chicago, Ill.

1900. *Illinois Steel Company. P. E. Carhart, Inspecting Engineer, 1139 Commercial National Bank Build ng, Chicago, Ill.

1911. Imperial Wire and Cable Company, Limited. Edward F. Sise, Managing Director, Box 3210, Montreal, Canada.

1906. Ingalls, F. P. Chemist, John W. Masury and Son, 15 Glenada Place, Brooklyn, N. Y.

1911. *Ingberg, S. H. Structural Engineer, 5601 Wash'ngton Avenue, Chicago, Ill.

1912. Inland Steel Company. G. H. Jones, Vice-President, 1105 First National Bank Building, Chicago, Ill.

1912. Inspection Department, Associated Factory Mutual Fire Insurance Company. C. H. Phinney, Secretary of Department, 31 Milk Street, Boston, Mass.

ELECTED.

1902. INTERNATIONAL ACHESON GRAPHITE COMPANY. Manufacturers of Graphite and Graphite Articles. W. Acheson Smith, Vice-President, Niagara Falls, N. Y.

1904. *INTERNATIONAL HARVESTER COMPANY. John G. Wood, Manager, Western Works, 1100 Harvester Building, Chicago, Ill.

1908. *INTERNATIONAL PAPER COMPANY. Charles F. Rhodes, Superintendent, Bureau of Tests, Glens Falls, N. Y.

1911. *INTERSTATE IRON AND STEEL COMPANY. S. J. Llewellyn, President, First National Bank Building, Chicago, Ill.

1911. IRELAND, W. G. Special Representative, Jamison Coal and Coke Company, 1507 Oliver Building, Pittsburgh, Pa.

1906. *IRON AGE, THE. A. I. Findley, Editor, 14 Park Place, New York, N. Y.

IRONS, ROBERT H. (see *Central Iron and Steel Company*).

IRVINE, FRED K. (see *Rock Products*).

IRVING, T. C., JR. (see *Robert W. Hunt Company, Limited*).

JACKSON, H. A. (see *Eastern Hard Fibre Company*).

1912. JACOBY, HENRY S Professor of Bridge Engineering, Cornell University, 58 Thurston Avenue, Ithaca, N. Y.

1896. JARECKI, ALEXANDER. Superintendent, Jarecki Manufacturing Company, Limited, Erie, Pa.

1905. JEFFERS, JOHN M. Oil Inspector, National Tube Company, 1603 Jenny Lind Street, McKeesport, Pa.

1911. ‡JEFFERSON, H. F. Assistant Manager, United and Globe Rubber Manufacturing Company, 2002 Farmers' Bank Building, Pittsburgh, Pa.

1910. *JENKINS, A. LEWIS. Assistant Professor of Mechanical Engineering, University of Cincinnati, Cincinnati, O.

JENKINS, WESTON, JR. (see *Rome Merchant Iron Mill*).

1908. JENKS, ROBERT J. Manager, Berwind-White Coal Mining Company, 1 Broadway, New York, N. Y.

1910. *JENNINGS, ROBERT E. President, The Carpenter Steel Company, 100 Broadway, New York, N. Y.

1911. *‡JENNINGS, ROBERT EUGENE, 2ND. Assistant Superintendent, Titan Steel Casting Company, 40 Park Place, Newark, N. J.

1909. ‡JENNISON, H. C. Testing of Materials, The Coe Brass Manufacturing Company, Ansonia, Conn.

ELECTED.

1912. JENSEN, J. NORMAN. Architectural Engineer, Department of Buildings, City Hall, Chicago, Ill.

1900. *JEWETT, J. Y. Cement Expert, United States Reclamation Service, 408 Commonwealth Building, Denver, Colo.

1900. JOB, ROBERT. Vice-President, Milton Hersey Company, Limited, 171 St. James Street, Montreal, Canada.

1903. *JOHNSON, ALBERT L. Second Vice-President, Corrugated Bar Company, Mutual Life Building, Buffalo, N. Y.

1903. JOHNSON, ARTHUR N. State Highway Engineer, Springfield, Ill.

1910. JOHNSON, CHARLES W. Assistant Manager of Works, Westinghouse Electric and Manufacturing Company, 5890 Hobart Street, Pittsburgh, Pa.

JOHNSON, E. V. (see *National Fireproofing Company*).

JOHNSON, GILBERT H. (see *Isaac G. Johnson and Company*).

JOHNSON, J. E. (see *Lake Superior Iron and Chemical Company*).

1904. JOHNSON, J. S. A. Professor of Experimental Engineering, Virginia Polytechnic Institute, Blacksburg, Va.

1904. JOHNSON, LEWIS J. Professor of Civil Engineering, Harvard University, 309 Pierce Hall, Cambridge, Mass

JOHNSON, PHELPS (see *Dominion Bridge Company*).

1910. ‡JOHNSON, REEVES K. Engineer of Tests, Baldwin Locomotive Works, Philadelphia, Pa.

1911. *JOHNSON AND COMPANY, ISAAC G. Gilbert H. Johnson, Treasurer, Spuyten Duyvil, New York, N. Y.

1912. *JOHNS-PRATT COMPANY, THE. Robert B. Lattin, Electrical Engineer, 555 Capitol Avenue, Hartford, Conn.

JOHNSTON, W. A. (see *The S. S. White Dental Manufacturing Company*).

1906. JOHNSTON, WILLIAM A. Associate Professor of Mechanical Engineering, Massachusetts Institute of Technology Boston, Mass.

JOHNSTONE, A. P. (see *The Sherwin-Williams Company*).

1902. *JONES AND LAUGHLIN STEEL COMPANY. Willis L. King, Vice-President, Pittsburgh, Pa.

1905. *JONES, C. R. Professor of Mechanical Engineering, West Virginia University, Morgantown, W. Va.

JONES, G. H. (see *Inland Steel Company*).

ELECTED.

1911. ‡JONES, H. M. Chemist, Engineering Department of Salt Lake, 504 City and County Building, Salt Lake City, Utah.

1909. JONES, JESSE L. In charge of Physical and Chemical Laboratory, Research Division, Westinghouse Electric and Manufacturing Company, Pittsburgh, Pa. *For Mail:* 612 E Street, Oakmont, Pa.

1908. JONES, JOHN H. President, The Pittsburg-Buffalo Com pany, 414 Frick Building, Pittsburgh, Pa.

1911. ‡JONES, JOHN L. Assistant Professor of Mechanical Engineering, Oklahoma Agricultural and Mechanical College, 303 West Street, Stillwater, Okla.

1909. JONES, J. RAYMOND. Engineering Department, Alan Wood Iron and Steel Company, Morris Building, Philadelphia, Pa.

1911. *JONES, MORGAN T. President, Morgan T. Jones Company, 419 Monadnock Block, Chicago, Ill.

1908. JONES, SULLIVAN W. Architect, 63 William Street, New York, N. Y.

1908. JONSON, ERNST. Engineer Inspector, Board of Water Supply, 147 Varick Street, New York, N. Y.

1910. ‡JORDAN, HARRY E. Superintendent, Filtration Department, Indianapolis Water Company, 113 Monument Place, Indianapolis, Ind.

1912. JOSEPH, J. G. President, Buffalo Steel Company, Tonawanda, N. Y.

1908. JOSIAS, HERMAN. Purchasing Agent, The Cuba Railroad, 52 William Street, New York, N. Y.

1911. JUMPER, CHARLES H. Chemical Engineer, Research Department, General Motor Company, Detroit, Mich.

JUNKENFELD, P. (see *Commonwealth-Edison Company*).

KAELBLE, CARL (see *Technischer Verein, New York*).

1912. KANSAS STATE AGRICULTURAL COLLEGE LIBRARY. A. B. Smith, Librarian, Manhattan, Kan.

1910. *KARR, C. P. 1108 Putnam Avenue, Plainfield, N. J.

1906. *KAUFMAN, GUSTAVE. Contracting Engineer, 85 Ninth Street, Brooklyn, N. Y.

1907. *KAVANAUGH, WILLIAM H. Professor of Experimental Engineering, University of Minnesota, Minneapolis, Minn.

1904. *KAY, EDGAR B. Professor of Engineering, University of Alabama, University, Ala.

ELECTED.

Kay, J. A. (see *The Railway Gazette*).

1907. Kaylor, John J. Inspector, Atchison, Topeka and Santa Fé Railway, 1616 Orchlee Street, N. S., Pittsburgh, Pa.

Keally, A. A. (see *Sharon Steel Hoop Company*).

1906. Kearns, W. F. President, William F. Kearns Company, 240 Albany Street, Cambridge, Mass.

1903. Keay, H. O. Professor of Transportation, and Director of Department of Railways, McGill University, Montreal, Canada.

1911. ‡Keeler, Warren I. Chemist, Valentine and Company, Brooklyn, N. Y., and President, Davenport and Keeler, Incorporated, New Britain, Conn., 364 Manhattan Avenue, Brooklyn, N. Y.

1910. *Keller, Arthur R. Professor of Civil Engineering, College of Hawaii, 1560 Magazine Street, Honolulu, T. H.

1910. Kelley, Frederick W. Vice-President, Helderburg Cement Company, 78 State Street, Albany, N. Y.

1912. Kelley Island Lime and Transportation Company. Lawrence Hitchcock, General Sales Manager, Cleveland, O.

1910. Kellogg and Sons, Spencer. Special Oil Departments, Buffalo, N. Y.

1910. *‡Kelsey, Victor V. Chemist, Carolina, Clinchfield and Ohio Railway, Erwin, Tenn.

1908. Kemmerer, John L. Coal Operator, 143 Liberty Street, New York, N. Y.

1912. Kendig, R. B. General Mechanical Engineer, New York Central Lines, Grand Central Station, New York, N. Y.

Kenerson, William H. (see *Brown University, Department of Mechanical Engineering*).

1899. Kennedy, Frank G., Jr. 1312 Morris Building, Philadelphia, Pa.

1904. *Kennedy, Jeremiah J. Consulting Engineer, 52 Broadway New York, N. Y.

1912. Kennedy, J. Sarsfield. Architect, Temple Bar Building, Brooklyn N. Y.

1904. *Kenney, E. F. Metallurgical Engineer, Cambria Steel Company, Johnstown, Pa.

1906. Kenney, Lewis Hobart. Draftsman in charge, Manufacturing Department, Machinery Division, United States Navy Yard, Philadelphia, Pa.

1902. Kent, William. Professor of Mechanical Engineering, 49 Union Street, Montclair, N. J.

ELECTED.

1908. KENT, W. C. Second Vice-President, Whitehall Portland Cement Company, 1722 Land Title Building, Philadelphia, Pa.

KERLIN, W. D. (see *Camden Forge Company*).

1910. *‡KERR, C. H. Research Ceramic Chemist, Pittsburg Plate Glass Company, Creighton, Pa.

1911. KERSHAW, WILLIAM H. Engineer, Paving and Roads Division, The Texas Company, 17 Battery Place, New York, N. Y.

1911. KESSLER, J. J. President, Dielectric Manufacturing Company, 224 South Vandeventer Avenue, St. Louis, Mo.

1905. KETCHUM, MILO S. Dean of the College of Engineering, and Professor of Civil Engineering, University of Colorado, Boulder, Colo.

1908. *KEWISH, W. H. Superintendent Plant No. 10, The Canadian Cement Company, Calgary, Albertha, Canada.

1907. KIEFER, H. E. Chemist, Edison Portland Cement Company, Stewartsville, N. J.

1912. ‡KIEFER, HERMAN G. Metallurgist, Timken Roller Bearing Company, Canton, O.

1903. KIESEL, W. F., JR. Assistant Mechanical Engineer, Pennsylvania Railroad Company, Altoona, Pa.

1906. *KIMMEL, H. R. Chemist, Industrial Testing Laboratory, Superior Building, Cleveland, O.

1911. *KIND, MORRIS. General Manager, Pacific Portland Cement Company, Cement, Cal.

1911. KING, CARL. Instructor, Wentworth Institute, Boston, Mass , 7 St. John Street, Jamiaca Plain, Mass.

1910. KING, D. M. Major, Ordnance Department, United States Army, Rock Island Arsenal, Rock Island, Ill.

1911. *KING, GEORGE I. Chief Engineer, Middletown Car Company, Middletown, Pa. *For Mail:* Standard Steel Car Company, Butler, Pa.

KING, WILLIS L. (see *Jones and Laughlin Steel Company*).

1899. *KINKEAD, J. A. Manager of Sales, The Parkesburg Iron Company, 2601 Singer Building, New York, N. Y.

1908. *‡KINNEY, WILLIAM M. Assistant Inspecting Engineer, Universal Portland Cement Company, 522 Frick Building, Pittsburgh, Pa.

1902. *KIRCHHOFF, C. Rhineland Court, 244 Riverside Drive, New York, N. Y.

ELECTED.

1903. *KIRCHNER, PAUL A. Structural Engineer, 40 West Thirty-sixth Street, New York, N. Y.

1909. ‡KIRSCHBRAUN, LESTER. Asphalt Chemist, City of Chicago, 160 North Fifth Avenue, Chicago, Ill.

1903. *KITTREDGE, H. G. Secretary, The Kay and Ess Company, Dayton, O.

1912. *KLEIN, OTTO H. Director, Standard Testing Laboratory of New York City, 127 Franklin Street, New York, N. Y.

1910. *‡KLEIN, WILLIAM H. Superintendent, Dixie Portland Cement Company, Richard City, Tenn.

1910. ‡KNAPPENBERGER, H. L. Chief Chemist, The Vancouver Portland Cement Company, Limited, Tod Inlet, British Columbia, Canada.

1903. *KNIGHTON, J. A. Department of Bridges, Park Row Building, New York, N. Y.

1906. *KNISELY, EDWARD S. Western Representative, Bethlehem Steel Company, Box 1017, Pittsburgh, Pa.

1909. KOCH, GEORGE B. Foreman, Physical Laboratory, Pennsylvania Railroad Company, 809 Chestnut Avenue, Altoona, Pa.

1912. ‡KOHLHOFER, ADOLPH J. Civil Engineer, New Lebanon, N. Y.

1903. KOHR, D. A. Chemist, The Lowe Brothers Company, Dayton, O.

1912. ‡KOMMERS, J. B. Instructor in Mechanics, University of Wisconsin, Madison, Wis.

1906. *KRANZ, W. G. Superintendent, Steel Casting Works, The National Malleable Castings Company, Sharon, Pa.

1896. *KREUZPOINTNER, PAUL. Pennsylvania Railroad Company, Altoona, Pa.

1904. KRUPP COMPANY, FRIED. Emil Ehrensberger, Director, Essen, Germany.

1911. *KUNZ, GEORGE F. Gem Expert, Tiffany and Company, 401 Fifth Avenue, New York, N. Y.

1908. LABORATORIO CENTRAL PARA EL ENSAYO DE MATERIALES. Escuela de Ingenieros de Caminos, Canales y Puertos, Madrid, Spain.

1903. LA CHICOTTE, H. A. Deputy Chief Engineer, Department of Bridges, 215 Park Row, New York, N. Y.

1905. *LACKAWANNA STEEL COMPANY. Franklin E. Abbott, Inspecting Engineer, Buffalo, N. Y.

ELECTED.

1908. LAFAYETTE COLLEGE LIBRARY. J. F. Stonecipher, Librarian, Easton, Pa.

1909. LAKE, EDWARD N. 147 Milk Street, Boston, Mass.

1910. *LAKE, HENRY B. Chemical Engineer, Canadian Pacific Railway, Winnipeg, Canada.

1910. *LAKE SUPERIOR IRON AND CHEMICAL COMPANY. J. E. Johnson, Jr., Manager, Ashland, Wis.

1912. LANE, F. A. General Manager, McCloskey Varnish Company, Thirtieth and Locust Streets, Philadelphia, Pa.

1906. LANE, H. C. Chief Draftsman, Maryland Steel Company, Sparrows Point, Md.

1903. *LANE, HENRY M. Foundry Engineer and Metallurgist, 10613 Greenlawn Avenue, Cleveland, O.

LANGDON, PALMER H. (see *The Metal Industry*).

1912. ‡LANGSTROTH, CLIFFORD B. Mechanical Engineer, 37 Lake Place, New Haven, Conn.

1899. *LANZA, GAETANO. The Montpelier, Sixty-third and Oxford Streets, Overbrook, Philadelphia, Pa.

LAPP, JOHN S. (see *The Locke Insulator Manufacturing Company*).

1904. *LARNED, E. S. Manager, United Building Materials Company, 101 Milk Street, Boston, Mass.

1903. LARSSON, C. G. E. Assistant Chief Engineer, American Bridge Company of New York, 30 Church Street, New York, N. Y.

1912. ‡LASIER, E. L. Laboratory Assistant, Bureau of Standards, Washington, D. C.

LATTIN, ROBERT B. (see *The Johns-Pratt Company*).

1910. LAVAL, LEON. Assistant Director, Dudelange Steel Works. *For Mail:* Care of Société Anomyme des Haute fourneaux, Grand Duche de Luxembourg, Germany.

1912. LAVERIE, ROBERT H. Chief Surveyor to the Bureau Veritas United States, 17 State Street, New York, N. Y.

1912. LAW, LEROY M. Chemist, Assistant Inspector of Asphalts and Cements, District of Columbia, 527 District Building, Washington, D. C.

1911. LAWRIE, JAMES W. Chief Chemist and Inspector of Raw Materials, The Pullman Company, 10106 Prospect Avenue, Chicago, Ill.

1907. LAWSON, THOMAS R. William Howard Hart, Professor of Rational and Technical Mechanics, Rensselaer Polytechnic Institute, 99 Twelfth Street, Troy, N. Y.

ELECTED.

1912. *Layman, Frank E. Ceramic Engineer, Cutler-Hammer Manufacturing Company, Milwaukee, Wis.

Layman, J. D. (see *University of Nevada Library*).

1908. Lazell, E. W. Edwards and Lazell, Consulting and Chemical Engineers, 426 Railway Exchange Building, Portland, Ore.

Le Chatelier, H. (see *Revue de Metallurgie*).

1911. *Ledoux and Company. A. M. Smoot, Chief Chemist, 99 John Street, New York, N. Y.

1909. *Lee, Ernest Eugene. Assistant Electrical and Mechanical Engineer, Isthmian Canal Commission, Culebra, Canal Zone.

1911. Leech, J. O. Inspection Department, Carnegie Steel Company, 519 Carnegie Building, Pittsburgh, Pa.

1910. Lehigh Valley Railroad Company. Stewart E. Printz, Material Inspector, Packerton, Pa.

1910. Leibfried, J. E. 19 North Main Street, Bethlehem, Pa.

1898. *Lesley, Robert W. President, American Cement Company, Pennsylvania Building, Philadelphia, Pa.

Levering, W. L. (see *Standard Asphalt and Rubber Company*).

1911. Lewis, Archer W. Chief Material Inspector, Norfolk and Western Railway Company, Roanoke, Va.

1907. Lewis, Ransome T. Manager, Elmira Plant, Empire Bridge Company, 412 West Clinton Street, Elmira, N. Y.

1904. *Lidgerwood, John H., Jr. Engineer, Lidgerwood Manufacturing Company, 96 Liberty Street, New York N. Y.

Liggett, Thomas, Jr. (see *United States Sherardizing Company*).

1911. *Lincoln, Incorporated, E. S. Consulting Engineer, Brookline, Mass.

1908. Lincoln, H. J. Inspector, Atchison, Topeka, and Santa Fé Railway, 407 Ross Avenue, Wilkinsburg, Pa.

1910. *Lindau, A. E. Western Manager, Corrugated Bar Company, Commercial National Bank Building, Chicago, Ill.

1911. *‡Lindemuth, Lewis B. With Pennsylvania Steel Company, Steelton, Pa.

1909. *Linder, Oscar. Chief of Testing Laboratories, Western Electric Company, Hawthorne, Ill.

1909. *Lindhard, P. T. Secretary, F. L. Smidth Company, 50 Church Street, New York, N. Y.

ELECTED.

1911. *‡LINDSAY, R. W. Chemist, Pratt and Lambert, Buffalo, N. Y.

1909. *LIPSCY, THOMAS E. L. Assistant Engineer, Isthmian Canal Commission, Culebra, Canal Zone.

LITCHFIELD, NORMAN (see *American Electric Railway Engineering Association*).

1903. *LITTLE, INCORPORATED, A. D. C. F. Woods, Secretary, 93 Broad Street, Boston, Mass.

1908. LITTLE, CHARLES N. Professor of Civil Engineering, Idaho State University, 818 Elm Street, Moscow, Idaho.

LLEWELLYN, S. J. (see *Interstate Iron and Steel Company*).

1912. LLOYDS' REGISTER OF SHIPPING. James H. Mancor, Principal Surveyor, United States and Canada, 17 Battery Place, New York, N. Y.

1903. LOBDELL, W. W. President, Lobdell Car Wheel Company, Wilmington, Del.

1902. LOBER, J. B. (*Member of Executive Committee*). President, Vulcanite Portland Cement Company, Land Title Building, Philadelphia, Pa.

1911. LOCK, ROBERT. President and General Manager, Apollo Steel Company, Apollo, Pa.

1909. LOCKE INSULATOR MANUFACTURING COMPANY, THE. John S. Lapp, Secretary, Victor, N. Y.

1908. LOCKWOOD, GREENE AND COMPANY. Architects and Engineers for Industrial Plants, 93 Federal Street, Boston, Mass.

1908. ‡LOEPSINGER, ALBERT J. Laboratory Engineer, General Fire Extinguisher Company, 41 Atlantic Avenue, Providence, R. I.

1905. *LOHMANN, H. W. Manager, James Stewart and Company, Engineers and Contractors, 302 Lincoln Trust Building, St. Louis, Mo.

1905. LONG, E. McLEAN. Long and Miller, 172 Fulton Street, New York, N. Y.

LORD, R. D. (see *Pittsburg Forge and Iron Company*).

LOUDENBECK, HARRY C. (see *Westinghouse Air Brake Company*).

1908. *LOVELL, ALFRED. Consulting Engineer, 819 Harrison Building, Philadelphia, Pa.

1910. LOW, FRANK S. Director, Experimental and Research Department, Patton Paint Company, 215-231 Lake Street, Milwaukee, Wis.

ELECTED.

1906. Low, Wilson H. Head Chemist, The Cudahy Packing Company, South Omaha, Neb.

1899. Lowe Brothers Company, The. Houston Lowe, President, Dayton, O.

Lowe, Houston (see *The Lowe Brothers Company*).

1900. *Loweth, Charles F. Chief Engineer, Chicago, Milwaukee and St. Paul Railway, 1232 Railway Exchange, Chicago, Ill.

1908. *Lucas and Company, John. Leo P. Nemzek, Chief Chemist, Gibbsboro, N. J.

1912. Ludlow, M. M. Chief Chemist, Southwestern States Portland Cement Company, Eagle Ford, Tex.

1909. *Ludlow Valve Manufacturing Company. James H. Caldwell, Vice-President, Troy, N. Y.

1908. *Luehrs, Daniel M. Mechanical Engineer, McCreery Engineering Company, Toledo, O.

1905. Lukens, Alan N. Mechanical Engineer, Railway Steel Spring Company, 30 Church Street, New York, N. Y.

1902. *Lukens Iron and Steel Company. Charles L. Huston, Vice-President, Coatesville, Pa.

1912. Lumsden, William G. Mechanical Engineer, Electric Boat Company, Groton, Conn.

1898. *Lundteigen, Andreas. Chemist, Peerless Portland Cement Company, Union City, Mich.

1912. ‡Lybrook, Raymond. Consulting Chemist, Bluefield, W. Va.

1906. Lynch, Thomas. President, H. C. Frick Coke Company, Carnegie Building, Pittsburgh, Pa.

1902. *Lynch, T. D. Engineer of Material Tests, Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.

1910. *Lyon, Frank. Lieutenant-Commander, United States Navy, 50 Franklin Street, Annapolis, Md.

Lyon, Tracy (see *General Motors Company*).

1911. *Lytle, C. W. General Manager, Hubbard Steel Foundry Company, East Chicago, Ind.

1912. *MacFarland, H. B. Engineer of Tests, Atchison, Topeka and Sante Fé Railway System, Topeka, Kan.

1910. *Macgregor, James S. Instructor in Civil Engineering, Columbia University, New York, N. Y.

1912. MacGregor, John R. Chemist, Picher Lead Company, 10136 Prospect Avenue, Chicago, Ill.

ELECTED.

1904. *MACK, J. LATHROP. Chief Chemist, Southern States Portland Cement Company, Box 83, Rockmart, Ga.

1908. MACKAY, H. M. Associate Professor of Civil Engineering, McGill University, Montreal, Canada.

1912. *‡MACKENZIE, KENNETH GERARD. Consulting Engineer, The Texas Company, Bayonne, N. J.

1895. *MACLAY, WILLIAM W. Consulting Engineer, Lee, Mass.

1910. MACNAB, S. D. Superintendent of Tests of Materials, McGill University, Montreal, Canada.

MACNAUGHTON, MALCOLM (see *Joseph Dixon Crucible Company*).

1909. MACNICHOL, CHARLES. Master Painter, 428 Tenth Street, Washington, D. C.

1902. MACPHERRAN, R. S. Chemist, Allis-Chalmers Company, West Allis Works, Milwaukee, Wis.

1910. *MAGEE, GUY, JR. Constructing Engineer, 136 Laurel Avenue, Wilmette, Ill.

1904. MAHON, R. W. Chemist, New York Central and Hudson River Railroad, West Albany, N. Y.

1907. MAIN, WILLIAM. Consulting Engineer and Chemist, 100 Broadway, New York, N. Y.

1902. MAJOR, CHARLES. Manager, Pencoyd Iron Works, American Bridge Company, Pencoyd, Pa.

MANCHOR, JAMES H. (see *Lloyds' Register of Shipping*).

1912. MANHATTAN RUBBER MANUFACTURING COMPANY. Eliah Henderson, Vice-President, Passaic, N. J.

1908. MANNHARDT, HANS. 1104 Oakdale Avenue, Chicago, Ill.

1912. ‡MANSFIELD, WARREN M. In charge of Physical Testing in Laboratory of Deere and Company, Moline, Ill. 843 Forty-fourth Street, Rock Island, Ill.

1898. *MARBURG, EDGAR (*Secretary-Treasurer*). Professor of Civil Engineering, University of Pennsylvania, Philadelphia, Pa.

1906. MARIS, JOHN M. Principal, School of Structural Engineering, International Correspondence Schools, Scranton, Pa.

1905. *MARQUETTE CEMENT MANUFACTURING COMPANY. T. G. Dickinson, Vice-President and General Manager, Marquette Building, Chicago, Ill.

1907. MARSH, C. P. Assistant to Engineer of Structures, New York Central and Hudson River Railroad, Room 1201, 335 Madison Avenue, New York, N. Y.

1905. MARSTON, A. Dean of Division of Engineering, Iowa State College, Ames, Iowa.

ELECTED.

1907. MARTIN, EDGAR D. Architect, 172 Washington Street, Chicago, Ill.

1902. MARTIN, SIMON S. Superintendent, Maryland Steel Company, Sparrows Point, Md.

1907. MARVIN, F. O. Dean, School of Engineering, University of Kansas, Lawrence, Kan.

1910. MARX, PAUL W. Chief Chemist, Great Western Portland Cement Company, Box 15, Mildred, Kan.

1908. ‡MASTERS, FRANK M. Pittsburg Representative of Ralph Mojeski, 607 Arnott Building, Pittsburgh, Pa.

1903. MASTERS, J. B. Inspecting Engineer, Pittsburgh Representative of Hildreth and Company, 506 North St. Clair Street, Pittsburgh, Pa.

1906. MASURY AND SON, JOHN W. 44 Jay Street, Brooklyn, N. Y.

1911. *MATHESON, GEORGE, JR. General Manager, Spang, Chalfant and Company, Incorporated, Union Bank Building, Pittsburgh, Pa.

1903. *MATHEWS, JOHN A. Operating Manager and General Superintendent, Halcomb Steel Company, Syracuse, N. Y.

MATHEWSON, E. P. (see *Anaconda Copper Mining Company*).

1904. *MAURER, E. R. Professor of Mechanics, University of Wisconsin, Madison, Wis.

1910. MCBURNEY, HENRY. Civil Engineer, 520 Park Avenue, New York, N. Y.

1912. ‡MCCARTHY, GEORGE P., JR. Civil Engineer, 929 Iranistan Avenue, Bridgeport, Conn.

1896. MCCAULEY, H. K. Secretary and Treasurer, Altoona Iron Company, Altoona, Pa.

MCCLEARY, E. T. (see *Youngstown Sheet and Tube Company*).

1912. MCCLELLAND, ELWOOD H. Technology Librarian, Carnegie Library of Pittsburgh, Pittsburgh, Pa.

1906. MCCORMACK, HARRY M. Professor of Chemical Engineering, Armour Institute of Technology, Chicago, Ill.

1905. MCCREA, ARCHIBALD M. President, Union Spring and Manufacturing Company, Farmers' Bank Building, Pittsburgh, Pa.

1903. *MCCREADY, ERNEST B. Proprietor, Allentown Testing Laboratory, Fourth and Linden Streets, Allentown, Pa.

ELECTED.

1908. McCREATH AND SON, ANDREW S. Chemists, 121 Market Street, Harrisburg, Pa.

1909. *McCULLOCH, JOHN A. Mechanical Engineer, Juniper and Second Streets, Versailles Station, McKeesport, Pa.

McCULLOUGH, FRANCIS MICHAEL (see *The Carnegie Institute*).

1910. *McDONNELL, M. E. Chemist and Bacteriologist, Pennsylvania Railroad Company, Altoona, Pa.

1907. *McFARLAND, G. S. Chemist, The Wyman and Gordon Company, Worcester, Mass.

1903. McGILL UNIVERSITY LIBRARY. C. H. Gould, Librarian, Montreal, Canada.

1905. *McGRADY, J. W. Chief Inspector, Homestead Steel Works, Carnegie Steel Company, Munhall, Pa.

McGREW, J. CLARENCE (see *Hoyt Metal Company*).

1907. McGUIRE, JAMES C. Civil Engineer, 26 Cortlandt Street, New York, N. Y.

1906. McILHINEY, PARKER C. Consulting Chemist, 7 East Forty-second Street, New York, N. Y.

1896. *McKENNA, CHARLES F. Chemist, 1553 Hudson Terminal Building, 50 Church Street, New York, N. Y.

1911. *McKENNA, M. F. City Engineer, Bridgeport, Conn.

McKENNAN, J. B. (see *Colorado Fuel and Iron Company*).

1909. ‡McKENZIE, HERMAN E. Engineer of Timber Tests, Forest Products Laboratory, Madison, Wis.

1905. *McKIBBEN, FRANK P. Professor of Civil Engineering, Lehigh University, South Bethlehem, Pa.

1912. McLANAHAN, J. KING, JR. Lime Manufacturer, Hollidaysburg, Pa.

1902. *McLEOD, JOHN. Assistant to President, Carnegie Steel Company, Pittsburgh, Pa.

1909. McLURE, NORMAN R. Engineer, Phœnix Bridge Company and Phœnix Iron Company, Phœnixville, Pa.

1911. *McMASTER, H. B. Commissioner, Association of Metal Lath Manufacturers of the United States, 812 Wick Building, Youngstown, O.

1904. *McNAUGHER, D. W. Civil Engineer, Monongahela Bank Building, Pittsburgh, Pa.

1907. McNAUGHTON, J. P. General Sales Agent, Dominion Iron and Steel Company, Sydney, Nova Scotia, Canada.

ELECTED.

1904. *MEAD, CHARLES ADRIANCE. Engineer of Bridges, Board of Railroad Commissioners of the State of New Jersey, 165 Wildwood Avenue, Upper Montclair, N. J.

1899. MEADE, RICHARD K. General Manager, Tidewater Portland Cement Company, 807 Keyser Building, Baltimore, Md.

1902. MEIER, E. D. President and Chief Engineer, Heine Safety Boiler Company, 11 Broadway, New York, N. Y.

1912. ‡MELICK, W. L. Assistant Chemist, Columbus Water Purification Works, 93 Price Street, Columbus, O.

MELLOR, J. W. (see *The English Ceramic Company*).

1910. *MERIWETHER, COLEMAN. President and Chief Engineer, Lock Joint Pipe Company, 165 Broadway, New York, N. Y.

1895. *MERRIMAN, MANSFIELD (*Past President*). Consulting Engineer, 1071 Madison Avenue, New York, N. Y.

1909. *METAL INDUSTRY, THE. Palmer H. Langdon, Editor and Publisher, 61 Beekman Street, New York, N. Y.

1910. *MICHAELIS, W., JR., Consulting Engineer for the *Cement Industry*, Schiller Building, Chicago, Ill.

1912. ‡MICKEY, CLARK EDWIN. Adjunct Professor of Applied Mechanics and Machine Design, University of Nebraska, Lincoln, Neb.

1909. *MIDVALE STEEL COMPANY. Radclyffe Furness, Engineer in charge of Research, Philadelphia, Pa.

1910. MILES, JOHN B. Member of Firm, Frank C. Roberts and Company, Real Estate Trust Building, Philadelphia, Pa.

1912. ‡MILLER, HAROLD J. Civil Engineer, 43 Smith Street, Portchester, N. Y.

MILLER, J. R. (see *Denny-Renton Clay and Coal Company*).

1903. *MILLER, RUDOLPH P. Superintendent of Buildings, Borough of Manhattan, 220 Fourth Avenue, New York, N. Y.

1900. MILLS, CHARLES M. Consulting Engineer, 4813 Beaumont Avenue, Philadelphia, Pa.

1910. *MILLS, JAMES W. Chief Chemist, National Enameling and Stamping Company, Granite City, Ill.

1910. *MILLWOOD, JAMES P. Chemist, United States Navy Yard, 246 Willoughby Avenue, Brooklyn, N. Y.

1909. *MILWAUKEE ELECTRIC RAILWAY AND LIGHT COMPANY. John I. Beggs, President and General Manager, Milwaukee, Wis.

ELECTED.

1912. MINER, JOSHUA L. Solicitor and Inspector, Pittsburgh Testing Laboratory, Room 386, 50 Church Street, New York, N. Y.

1910. *MISSOURI PACIFIC RAILWAY COMPANY. E. F. Mitchell, Chief Engineer, St. Louis, Mo.

1907. MITCHELL, A. E. Vice-President, The Wychoff Pipe and Creosoting Company, Incorporated, 50 Church Street, New York, N. Y.

MITCHELL, E. F. (see *Missouri Pacific Railway Company*).

1912. MIX, WILLIAM E. Director, El Paso Testing Laboratory, El Paso, Tex.

1903. *MOISSEIFF, LEON S. Assistant Engineer to Commissioner of Bridges, 13 Park Row, New York, N. Y.

1896. *MOLDENKE, RICHARD (*Member of Executive Committee*). Metallurgist, Consulting Engineer, Watchung, N. J.

MOLINEAUX, ROLAND (see *Devoe and Raynolds Company*).

1908. MOLLESON, GEORGE E. Manager, Railroad Department, Tyler Tube and Pipe Company, 50 Church Street, New York, N. Y.

1906. MONTANA COLLEGE OF AGRICULTURE AND MECHANIC ARTS. Bozeman, Mont.

1912. ‡MONTFORT, BARRET. Civil Engineer, Cherokee Park, Louisville, Ky.

1903. *MOORE, HERBERT F. Assistant Professor of Theoretic and Applied Mechanics, University of Illinois, 915 West Oregon Street, Urbana, Ill.

1909. ‡MOORE, JOSEPH K. Assistant Manager, Western Clay Company, 508 Beck Building, Portland, Ore.

MOORE, W. E. (see *West Penn Traction Company*).

1902. MOORE, WILLIAM HARLEY. Engineer of Bridges, New York, New Haven and Hartford Railroad Company, New Haven, Conn.

1909. *MORRIS, D. A. Metallurgical Engineer, Nelson Valve Company, Chestnut Hill, Philadelphia, Pa.

MORRIS, W. CULLEN (see *Society of Gas Engineering of New York*).

1911. *‡MORROW, JAMES G. Inspecting Engineer, The Steel Company of Canada, Hamilton, Ontario, Canada.

1910. *MORSE, F. B. District Manager, Gulick-Henderson Company, 30 Church Street, New York, N. Y.

1910. *MORSE, ROBERT G. Assistant Treasurer, Massachusetts Steel Casting Company, Everett, Mass.

ELECTED.

1911. MORY, A. V. H. Director of Chemical Research, Sears, Roebuck and Company, Chicago, Ill.

1904. MOSELEY, ALEXANDER W. Professor of Applied Mechanics, Lewis Institute, Chicago, Ill.

1909. MOYER, ALBERT. Manager, Sales Department, Vulcanite Portland Cement Company, 175 Fifth Avenue, New York, N. Y.

1909. MUCKENFUSS, A. M. Professor of Chemistry, University of Mississippi, University, Miss. *For Mail:* 203 Twenty-second Street, Milwaukee, Wis.

MUELLER, FRANK E. (see *Roberts and Schaeffer Company*).

1899. *MUESER, WILLIAM. Civil Engineer; Member, Concrete Steel Engineering Company, 13–21 Park Row Building, New York, N. Y.

1908. *MUHLFELD, JOHN E. Vice-President and General Manager, Kansas City Southern Railway Company, 3712 Washington Street, Kansas City, Mo.

1903. MUNROE, CHARLES EDWARD. Head Professor of Chemistry, George Washington University, Washington, D. C.

1904. MUNSELL, A. W. Inspector of Materials, 301 Sun Building, Detroit, Mich.

1908. MUNSELL, J. A. Assistant Cement Inspector, Erie Railroad, Ninth and Provost Streets, Jersey City, N. J.

1912. ‡MURDOCK, CHARLES W. Civil Engineer, Crown Point, N. Y.

1910. MURPHY, DANIEL H. President, American Conduit Manufacturing Company, 1402 Keystone Building, Pittsburgh, Pa.

1912. ‡MURRAY, JOSEPH A., JR. Civil Engineer, 80 Dana Avenue, Albany, N. Y.

1910. *MURTAUGH, M. M. Consulting Hydraulic and Construction Engineer, 4 and 5 Twin Falls Bank Building, Twin Falls, Idaho.

1910. MYER, C. R. Engineer in charge, Line Inspection Material, Western Electric Company, 463 West Street, New York, N. Y.

1910. MYERS, J. E. Chemist, New York State Highway Commission, 81 Lancaster Street, Albany, N. Y.

1910. NAIRN LINOLEUM COMPANY, THE. Newark, N. J.

1908. NATIONAL CASH REGISTER COMPANY, THE. Manufacturers of Cash Registers. E. A. Deeds, Second Vice-President, Dayton, O.

ELECTED.

1905. NATIONAL FIREPROOFING COMPANY. E. V. Johnson, Vice-President and Western Manager, 806 Hartford Building, Chicago, Ill.

1912. *NATIONAL LIME MANUFACTURERS ASSOCIATION. William E. Carson, President, Riverton, Va.

1911. NATIONAL PETROLEUM NEWS, THE. W. C. Platt, Editor, Rose Building, Cleveland, O.

1900. *NATIONAL TUBE COMPANY. Frank N. Speller, Metallurgical Engineer, Frick Building, Pittsburgh, Pa.

1911. *‡NEAD, J. H. Metallurgist, H. H. Franklin Manufacturing Company, 208 Putnam Street, Syracuse, N. Y.

1909. NEAL, C. S. Manager, White Lead Department, Acme White Lead and Color Works, Detroit, Mich.

NEALE, JAMES (see *Brown and Company, Incorporated*).

1902. *NEFF, F. H. Professor of Civil Engineering, Case School of Applied Science, Cleveland, O.

1912. ‡NELSON, ERNEST B. Heroult, Cal.

1904. *NELSON, E. D. Former Engineer of Tests, Pennsylvania Railroad Company, 74 New England Avenue, Summit, N. J.

1910. NELSON, GEORGE. City Engineer, Hermosa Beach, Cal.

1910. NELSON, JOHN H. Assistant Professor, Head of Department of Applied Mechanics, Case School of Applied Science, Cleveland, O.

NEMZEK, LEO P. (see *John Lucas and Company*)

1911. NEU, ADOLPH. Chemist, Knickerbocker Portland Cement Company, Hudson, N. Y.

1898. *NEWBERRY, SPENCER B. Manager, Sandusky Portland Cement Company, Sandusky, O.

1912. ‡NEWCOMB, ROBERT E. Assistant Superintendent, The Deane Steam Pump Company, 229 Chestnut Street, Holyoke, Mass.

1909. ‡NEWHALL, CHARLES A. Chemical Engineer, Newhall, Smith and Company, 605 Northern Bank Building, Seattle, Wash.

1909. *NEW JERSEY ZINC COMPANY. F. E. Pierce, Engineer, 55 Wall Street, New York, N. Y.

1912. NEWPORT NEWS SHIPBUILDING AND DRY DOCK COMPANY. A. S. Alexander, Assistant to the General Manager, Newport News, Va.

ELECTED.

1908. *NEW YORK CENTRAL AND HUDSON RIVER RAILROAD COMPANY, ENGINEERING DEPARTMENT. A. W. Carpenter, Engineer of Structures, Exterior Zone, Grand Central Terminal, New York, N. Y.

1904. NEW YORK FIRE INSURANCE EXCHANGE. Willis S. Robb, Manager, 32 Nassau Street, New York, N. Y.

1912. NICKERSON, J. F. Editor, *Ice and Refrigeration*, 431 South Dearborn Street, Chicago, Ill.

1907. *NIMMO, J. V. Care of Canadian Northern Pacific Railway, Burns Building, 18 Hastings Street, W., Vancouver, British Columbia, Canada.

1908. NOBLE AND COMPANY, R. E. Cement Experts, 217 Humboldt Bank Building, San Francisco, Cal.

1911. ‡NODERER, R. H. Chief Chemist, Lorain Steel Company, Johnstown, Pa.

1912 NORDELL, C. E. Civil Engineer, Long Branch, N. J.

1902. *NORRIS, GEORGE L. Engineer of Tests, American Vanadium Company, Frick Building, Pittsburgh, Pa.

1903. NORTON, C. L. Assistant Professor of Heat Measurement, Massachusetts Institute of Technology, Boston, Mass.

1910. NORTON, HOMER B. Chief Engineer, Elk Tanning Company, 302 Adams Avenue, Ridgeway, Pa.

1909. *NOVELLA, CHARLES F. Engineer, Guatemala City, Guatemala.

1912. NUESSEY, WILLIAM H. Assistant Engineer of Motive Power, Long Island Railroad Company, Richmond Hill, N. Y.

1910. *OAKDEN, W. L. Director, Research Laboratory, American Optical Company, Southbridge, Mass.

1909. *OBER, JULIUS E. Metallurgist and Chemist, West Penn Steel Company, 222 North Craig Street, Pittsburgh, Pa.

1911. *OBERKIRCH, FRANK. President and General Manager, St. Mary's Sewer Pipe Company, St. Marys, Pa.

1911. ‡OEHLER, E. H. Chief Chemist, General Roofing and Manufacturing Company, 1723 St. Louis Avenue, East St. Louis, Ill.

1911. OGDEN, BENJAMIN. John Davenport Company, Stamford, Conn.

1908. *O'HARA, J. M. Official Cement Tester, Southern Pacific Company, 1109 Flood Building, San Francisco, Cal.

ELECTED.

1898. *OLSEN, TINIUS. Tinius Olsen and Company, Testing Machines, 500 North Twelfth Street, Philadelphia, Pa.

1911. *OLSEN, THORSTEN Y. General Manager, Tinius Olsen and Company, 500 North Twelfth Street, Phi adelphia, Pa.

1910. O'MALLEY, WILLIAM. Assistant Engineer, The Cuban Central Railways, Prado 93*a*, Havana, Cuba.

1912. ONDERDONK, J. R. Engineer of Tests, Balt'more and Ohio Railroad Company, Mt. Clare, Balt'more, Md.

1912. *‡O'NEILL, WILLIAM CHARLES, JR. In charge of Materials Testing Department, Electrical Testing Laboratories, 44 West One Hundred and Sixth Street, New York, N. Y.

1903. ORFORD COPPER COMPANY. H. E. Flewellin, 43 Exchange Place, New York, N. Y.

1911. ‡ORR, GEORGE. Assistant to City Engineer, 9 Cottage Street, Gloversville, N. Y.

1902. ORTON, EDWARD, JR. Dean, College of Engineering, Ohio State University; State Geologist of Ohio, Columbus, O.

1911. OSBORN, C. J. Dry Colorer, 268 Water Street, New York, N. Y.

1898. OSBORN ENGINEERING COMPANY, THE. Frank C. Osborn, 740 Engineers Building, Cleveland, O.

OSBORN, FRANK C. (see *The Osborn Engineering Company*).

1911. *‡OSBORNE, CHARLES G. Superintendent, Special Steels, Illinois Steel Company, South Works, Chicago, Ill.

OSBORNE, L. A. (see *Westinghouse Electric and Manufacturing Company*).

1907. OSBORNE, RAYMOND GAYLORD. Inspector of Cement, 401 West Twenty-third Street, Los Angeles, Cal.

1903. *OSTROM, JOHN N. Bridge Engineer, 1518 Farmers' Bank Building, Pittsburgh, Pa.

1904. *OTIS, SPENCER. Mechanical Engineer, 1707 Railway Exchange Building, Chicago, Ill.

1902. *OUTERBRIDGE, ALEXANDER E., JR. Chemist and Metallurgist, 1600 Hamilton Street, Philadelphia, Pa.

1904. *OWEN, JAMES. Civil Engineer, 196 Market Street, Newark, N. J.

OWENS, R. B. (see *Franklin Institute*).

1903. PAGE, LOGAN WALLER. Director, Office of Public Roads, United States Department of Agriculture, Washington, D. C.

1909. PAGE, W. MARSHALL. Engineer, Duplex Metals Company, Chester, Pa.

ELECTED.

1908. Page, William Nelson. President, Gauley Mountain Coal Company, Ansted, W. Va.

Papst, Stilman (see *Portland Gas and Coke Company*).

1911. Pardee, Homer A. Metallurgical Chemist, Crucible Steel Company of America, Syracuse, N. Y.

1912. *Parish, W. F. Manager, Lubricating Division, The Texas Company, 17 Battery Place, New York, N. Y.

Park, W. L. (see *Illinois Central Railroad Company*).

Parker, E. L. (see *Columbia Steel and Shafting Company*).

Parker, J. H. (see *The Carpenter Steel Company*).

1908. *Parr, S. W. Professor of Applied Chemistry, University of Illinois, Urbana, Ill.

1912. Patent Office Library. 25 Southampton Buildings, London, W. C., England.

Paterson, J. V. (see *Seattle Construction and Dry Dock Company*).

Patterson, W. J. (see *Heyl and Patterson, Incorporated*).

1906. Patton, Ludington. Secretary-Treasurer, Patton Paint Company, Milwaukee, Wis.

1911. ‡Patzig, Monroe L. Testing Engineer, 931 Fourth Street, Des Moines, Iowa.

1908. Paul, Charles E. Care of Armour Institute, Chicago, Ill.

1906. Payne, Henry. Professor of Engineering, University of Melbourne, Melbourne, Australia.

1908. Payne, T. P. Payne Brothers, Incorporated, Emmett Street and D Avenue, Newark, N. J.

1911. *Pease, Burton H. Chief Inspector, Carnegie Steel Company, Sharon, Pa.

1896. Pease, F. N. Chemist, Pennsylvania Railroad Company, Box 503, Altoona, Pa.

1908. Peck and Company, Francis J. Mining Engineers and Chemists, 731–735 Williamson Building, Cleveland, O.

Peck, Miss Harriet R. (see *Rensselaer Polytechnic Institute*).

1903. Peckitt, Leonard. President, Empire Steel and Iron Company, Catasauqua, Pa.

1909. *Peerless Motor Car Company, The. G. K. Wadsworth, Assistant to the President, Cleveland, O.

1912. Peffer, George Whitesell. General Superintendent, Open-hearth Steel Works, Republic Iron and Steel Company, Youngstown, O.

1912. Peirce, Edwin H. South Works, American Steel and Wire Company, Worcester, Mass.

ELECTED.

1911. *PENDER, BENJAMIN D. Inspector, Mechanical Division, Isthmian Canal Commission, Gorgona, Canal Zone.

PENNEY, R. L. (see *Winchester Repeating Arms Company*).

1906. PENNIMAN AND BROWNE. Consulting Chemists, 213 Courtland Street, Baltimore, Md.

1911. PENN STEEL CASTINGS AND MACHINE COMPANY. Walter S. Bickley, President and General Manager, Chester, Pa.

1909. *PENNSYLVANIA CRUSHER COMPANY. G. W. Borton, General Manager, Stephen Girard Building, Philadelphia, Pa.

1903. PENNSYLVANIA STATE HIGHWAY DEPARTMENT. Edward M. Bigelow, State Highway Commission, Harrisburg, Pa.

1902. PENNSYLVANIA STEEL COMPANY, THE. J. V. W. Reynders, Vice-President Steelton, Pa.

1908. *PENNY, EDGAR. Vice-President and General Manager, Newburgh Ice Machine and Engine Company, Newburgh, N. Y.

1912. ‡PENROD, ROBERT EARL. Department of Tests, Cambria Steel Company, 104 Union Street, Johnstown, Pa.

1912. *PERFECTION SPRING COMPANY, THE. Christian Girl, President and Manager, Cleveland, O.

1910. PERKINS, GEORGE H. Superintendent of Refineries, Warren Brothers Company, Boston, Mass. *For Mail:* 5 Irving Terrace, Cambridge, Mass.

1910. PERLEY, ALAN B. Consulting Engineer, 46 Gowen Avenue, Mt. Airy, Philadelphia, Pa.

1904. *PERLEY, GEORGE E. Cement Expert, Department of Public Works, Ottawa, Canada.

1907. PERRY, R. S. President, Harrison Brothers and Company, Incorporated, Philadelphia, Pa.

1912. PETERSON, GUSTAF. Road Engineer, Carnegie Steel Company, Pennsylvania Building, Philadelphia, Pa.

1905. *PEW, J. HOWARD. Assistant Manager of Refinery, Sun Company, Marcus Hook, Pa.

1911. ‡PHILLIPS, OLIVER. District Manager, Robert W. Hunt and Company, 1703 Union Trust Building, Cincinnati, Ohio.

1910. PHILLIPS, W. R. Mechanical Engineer, 419 Lumber Exchange Building, Portland, Ore.

PHINNEY, C. H. (see *Inspection Department, Associated Factory Mutual Fire Insurance Companies*).

ELECTED.

1909. Pickard, Glenn H. Care of G. D. Wetherill and Company, 114 North Front Street, Philadelphia, Pa.

1912. Pierce-Arrow Motor Car Company. David Ferguson, Chief Engineer, Buffalo, N. Y.

1912. Pierce, Dana. Electrical Engineer, Underwriters' Laboratories, 135 William Street, New York, N. Y.

Pierce, F. E. (see *New Jersey Zinc Company*).

1910. *Pinkerton, Andrew. Electrical Engineer, American Sheet and Tin Plate Company, 1007 Frick Building, Pittsburgh, Pa.

1904. *Pittsburg Forge and Iron Company. R. D. Lord, Secretary, Pittsburgh, Pa.

1905. *Pittsburg Testing Laboratory. John M. Bailey, Secretary, 325 Water Street, Pittsburgh, Pa.

Platt, W. C. (see *The National Petroleum News*).

1910. Plock, A. F. 3506 Fifth Avenue, Pittsburgh, Pa.

1910. ‡Plumb, R. Alfred. Director, Michigan Technical Laboratory, 58 Lafayette Avenue, Detroit, Mich.

1902. *Polk, Anderson. Associated with The Lowe Brothers Company, Dayton, O. *For Mail:* The Engineers' Club, 32 West Fortieth Street, New York, N. Y.

1906. Polson, Joseph A. East Lansing, Mich.

1904. *Pomeroy, Lewis R. Consulting Engineer, Room 1201, 105 West Fortieth Street, New York, N. Y.

1908. Poorman, Alfred P. Assistant Professor of Applied Mechanics, Purdue University, Lafayette, Ind.

1909. Pope, George S. Assistant Engineer, Technologic Branch, Bureau of Mines, Washington, D. C.

1912. Porter, F. B. President, The Fortworth Laboratories, 204½ Houston Street, Fort Worth Tex.

1911. *Porter, H. F. J. Industrial Engineer, 1 Madison Avenue, New York, N. Y.

1898. Porter, James Madison. Professor of Civil Engineering, Lafayette College, Easton, Pa.

1912. Portland Gas and Coke Company. Stilman Papst, General Manager, Portland, Ore.

Potter, Alfred C. (see *Harvard College Library*).

1907. *Potts, Stephen C. Assistant General Foreman, South Altoona Foundries, Pennsylvania Railroad Company, Altoona, Pa.

1912. Powell, William H. President, Atlantic Terra Cotta Company, 1170 Broadway, New York, N. Y.

ELECTED.

1903. *POWERS, W. A. Chief Chemist, Atchison, Topeka and Santa Fé Railroad, Topeka, Kan.

1904. *PRENTISS, GEORGE N. Chemist, Chicago, Milwaukee and St. Paul Railway Company, 226 Thirty-third Street, Milwaukee, Wis.

1904. PRESTON, S. R. Port Colbone, Ontario, Canada.

1909. *PRICE, CHARLES P. Manager, American Tar Company, Box 65, Malden, Mass.

1911. *PRICE, FRANK. Chief Shop Inspector, Isthmian Canal Commission, "Desoirs," Glen Cove, L. I.

1903. PRICE, MORTON MOORE. Sales Agent, Babcock and Wilcox Company, North American Building, Philadelphia, Pa.

PRINTZ, STEWART E. (see *Lehigh Valley Railroad Company*).

1905. *PROVOST, ANDREW J., JR. Sanitary Expert and Hydraulic Engineer, 39 West Thirty-eighth Street, New York, N. Y.

1908. *PRYOR, FREDERICK L. Professor of Experimental Engineering, Stevens Institute of Technology, Hoboken, N. J.

PULLAR, H. B. (see *American Asphaltum and Rubber Company*).

1904. PURDON, C. D. Chief Engineer, Cotton Belt Railroad, 6157 Kingsbury Boulevard, St. Louis, Mo.

1908. PURDUE UNIVERSITY LIBRARY. W. M. Hepburn, Librarian, Lafayette, Ind.

1903. QUIMBY, H. H. Chief Engineer, John G. Brown, Witherspoon Building, Philadelphia, Pa.

1909. RADER, B. H. Eastern Sales Agent, Universal Portland Cement Company, 524 Frick Building, Pittsburgh, Pa.

1902. RAILWAY AND ENGINEERING REVIEW. W. M. Camp, Editor, 1305 Manhattan Building, Chicago, Ill.

1912. RAILWAY GAZETTE, THE. J. A. Kay, Managing Editor, Queen Anne's Chambers Westminster, London, S. W., England.

1911. RAILWAY STEEL SPRING COMPANY. A. S. Henry, Vice-President, 30 Church Street, New York, N. Y.

RAKE, J. L. (see *Barber Asphalt Paving Company*).

1904. RAMAGE, J. C. Superintendent of Tests, Southern Railway Company, Alexandria, Va.

1904. *RAMSAY, H. MARTYN. General Inspector, Pennsylvania Railroad Company, Altoona, Pa.

ELECTED.

1908. Randall, D. T. Mechanical Engineer, Birmingham, Mich.

1896. *Randolph, Lingan S. Professor of Mechanical Engineering, Virginia Polytechnic Institute, Blacksburg, Va.

1907. *Raquet, E. H. Chief Chemist, New York, New Haven and Hartford Railroad Company, West Haven, Conn.

1911. Rawson, Charles A. President, Iowa Pipe and Tile Company, Des Moines, Iowa.

1912. *Ray, David H. Chief Engineer, Bureau of Building in Manhattan, 220 Fourth Avenue, New York, N. Y.

1909. Raymond Concrete Pile Company. Maxwell M. Upson, Secretary and General Manager, 140 Cedar Street, New York, N. Y.

1909. Raymond, M. Assistant Engineer, Department of Docks, 507 West One Hundred and Thirteenth Street, New York, N. Y.

1902. Reading Iron Company. George Schuhman, Vice-President and General Manager, Reading, Pa.

1910. ‡Rectanus, S. R. Superintendent, Galvanizing Department, American Rolling Mills Company, Middletown, O.

1910. *Reed, M. E. Lieutenant-Commander, United States Navy, School of Marine Engineering, United States Naval Academy, Annapolis, Md.

1904. Reeve, C. S. Assistant Chemist, Office of Public Roads, United States Department of Agriculture, Washington, D. C.

1911. ‡Reinke, W. B. Assistant Engineer, Henry S. Spackman Engineering Company, 42 North Sixteenth Street, Philadelphia, Pa.

1908. *Remington Arms and Ammunition Company. Nathan A. Chase, Chemist, Box 115, Ilion, N. Y.

1909. ‡Reninger, Henry A. Chemist, Lehigh Portland Cement Company, Allentown, Pa.

1907. Rensselaer Polytechnic Institute. Miss Harriet R. Peck, Librarian, Troy, N. Y.

1911. Revue de Metallurgie. H. Le Chatelier, Editor, 7 Rue de Madrid, Paris, France.

1906. Reynders, J. V. W. Vice-President, The Pennsylvania Steel Company, Steelton, Pa.

Reynolds, M. P. (see *W. S. Tyler Company*).

Rhodes, Charles F. (see *International Paper Company*).

1910. Rhodes, T. Eckford. Chief Engineer, Whitney-Steen Company, 1 Liberty Street, New York, N. Y.

ELECTED.

1909. RICE, H. A. Associate Professor of Civil Engineering, University of Kansas, 1233 Massachusetts Street, Lawrence, Kan.

RICE, HERBERT W. (see *United States Gutta Percha Paint Company*).

1900. RICHARDS, JOSEPH T. Chief Engineer, Maintenance of Way, Pennsylvania Railroad Company, Broad Street Station, Philadelphia, Pa.

1902. *RICHARDS, JOSEPH W. Professor of Metallurgy, Lehigh University, South Bethlehem, Pa.

1896. *RICHARDSON, CLIFFORD. Consulting Engineer, 30 Church Street, New York, N. Y.

1911. ‡RIDDELL, W. C. Chemical Engineer, Pacific Portland Cement Company, 823 Pacific Building, San Francisco, Cal.

1912. RIDDLE, GEORGE W. Assistant Engineer, Underwriters' Laboratories, 207 East Ohio Street, Chicago, Ill.

1910. *‡RIEGER, WILLIAM H. Chemist, Heppenstall Forge and Knife Company, Pittsburgh, Pa.

1902. RIEGNER, W. B. Engineer of Bridges, Philadelphia and Reading Railway Company, Reading Terminal, Philadelphia, Pa.

1898. *RIEHLÉ, FREDERICK A. Riehlé Brothers Testing Machine Company, 1424 North Ninth Street, Philadelphia, Pa.

1912. RIES, HEINRICH. Professor of Economic Geology, Cornell University, Ithaca, N. Y.

1912. *RIGG, ERNEST H. Naval Architect, New York Shipbuilding Company, Camden, N. J.

1910. RIGG, GILBERT. Chemist, Head of Research Department, New Jersey Zinc Company, Palmerton, Pa.

1908. RIGHTS, LEWIS D. Civil Engineer, care of L. F. Shoemaker and Company, 45 Broadway, New York, N. Y.

1907. *RINALD, C. D. Rinald Brothers, Paint Manufacturers, 1142 North Hancock Street, Philadelphia, Pa.

1909. RITTER, DANIEL E. Assistant to President, Lehigh Portland Cement Company, Allentown, Pa.

ROBB, WILLIS S. (see *New York Fire Insurance Exchange*).

1904. ROBERTS, ALFRED E. Analytical and Consulting Chemist and Metallurgist, Bull and Roberts, 100 Maiden Lane, New York, N. Y.

1908. ROBERTS AND SCHAEFER COMPANY. Consulting Engineers and Contractors. Frank E. Mueller, Secretary, 1270 Old Colony Building, Chicago, Ill.

ELECTED.

1912. ROBERTSON, H. H. President, Asbestos Protected Metal Company, Beaver Falls, Pa.

1904. ROBERTSON, LESLIE S. Secretary of the Engineering Standards Committee, 28 Victoria Street, London, England.

1904. *ROBINSON, A. F. Bridge Engineer, Atchison, Topeka and Santa Fé Railway System, 1000 Railway Exchange Building, Chicago, Ill.

1908. ROBINSON, A. L. Electrical Engineer, Isthmian Canal Commission, Culebra, Canal Zone.

1908. ROBINSON, C. SNELLING. Second Vice-President, Youngstown Sheet and Tube Company, Youngstown, O.

1910. ROBINSON, G. P. Assistant Chief Inspector Division of Locomotive Boiler Inspection, Interstate Commerce Commission, First National Bank Building, Columbus, O.

1911. ‡ROBINSON, LOUIS G. Engineer and Chemist, Harrison Building, Cincinnati, O.

1904. *ROCK PRODUCTS. Fred K. Irvine, Technical Editor, 537 South Dearborn Street, Chicago, Ill.

1906. RODGERS, S. M. Metallurgist, American Steel and Wire Company, 819 Frick Building, Pittsburgh, Pa.

1909. *RODMAN, H. B. Chemist, Chemical Laboratory, Pennsylvania Railroad Company, Altoona, Pa.

1900. *ROEBLING'S SONS COMPANY, JOHN A. H. J. Horne, Assistant Superintendent, Department of Wire-drawing, Trenton, N. J.

1910. ROGERS, ALLEN. In charge of Industrial Chemistry, Pratt Institute, Brooklyn, N. Y.

1910. ‡ROGERS, JOHN I. Eagan-Rogers Steel and Iron Company, Crum Lynn, Pa.

1908. ROGERS, R. E. Treasurer, James B. Sipe and Company, 516 Federal Street, Pittsburgh, Pa.

1911. ROME MERCHANT IRON MILL. Weston Jenkins, Jr., Superintendent, 30 Church Street, New York, N. Y.

1911. *ROSE, FLOYD. Inspecting Engineer, 901 Fulton Building, Pittsburgh, Pa.

1905. *ROSENHEIM, A. F. Architect, H. W. Hellman Building, Los Angeles, Cal.

1911. *ROSS, H. A. Treasurer, The Vancouver Portland Cement Company, Limited, Box 681, Victoria, British Columbia, Canada.

ELECTED.

1905. *ROSSI, JAMES C. General Superintendent, National Fireproofing Company, 71 Lewis St., Perth Amboy, N. J.

1909. ‡ROTE, JOHN G. Manager, Gillette Safety Razor Company, First and Colton Streets, Boston, Mass.

1911. ROTHSTEIN, E. KELLY. Vice-President and General Manager of Sales, Davis Coal and Coke Company, 700 Continental Building, Baltimore, Md.

1910. *ROWLAND, WILLIAM S. Chemical Engineer, The Stanley Works, New Britain, Conn.

1911. ‡ROYS, FRANCIS WILLIAM. Instructor in Mechanical Engineering, Worcester Polytechnic Institute, 132 Elm Street, Worcester, Mass.

1906. RUGGLES, WILLIAM B. Mechanical Engineer, 39 Cortlandt Street, New York, N. Y.

1912. RUMELY CO., M. J. E. Hallinen, Superintendent of Laboratories, La Porte, Ind.

RUNKLE, E. W. (see *Carnegie Library, Pennsylvania State College*).

1908. ‡RUPP, MANNING E. Inspecting Engineer, Isthmian Canal Commission, Pencoyd Iron Works, Pencoyd, Pa.

1911. *RUPPEL, HENRY E. K. Chemist, Gillette Safety Razor Company, 21 Wollaston Avenue, Wollaston, Mass.

1910. RUSSELL, A. A. M. Assistant Chemist, Board of Public Works, 349 Frederick Street, San Francisco, Cal.

1906. *RUSSELL, ERNEST JOHN. Architect, Chemical Building, St. Louis, Mo.

RUSSELL, N. F. S. (see *United States Cast Iron Pipe and Foundry Company*).

1904. RUTHENBURG, MARCUS. Metallurgical Engineer, Electrical Federation Offices, Kingsway, London, W. C., England.

1908. RYERSON AND SON, JOSEPH T. Iron and Steel. Edward T. Hendee, Sixteenth and Rockwell Streets, Chicago, Ill.

1908. *RYS, C. F. W. Metallurgical Engineer, Carnegie Steel Company, 521 Carnegie Building, Pittsburgh, Pa.

1898. SABIN, A. H. Chemist, 432 Sanford Avenue, Flushing, N. Y.

1902. *SABIN, L. C. General Superintendent, St. Mary's Falls Canal, Sault Ste. Marie, Mich.

1911. SADTLER AND SON, SAMUEL P. Consulting and Analytic Chemists, 39 South Tenth Street, Philadelphia, Pa.

ELECTED.

1909. *SAKLATWALLA, B. Metallurgist, American Vanadium Company, Bridgeville, Pa.

1904. *SALMON, FREDERICK W. Civil and Mechanical Engineer, 109 South Woodlawn Avenue, Burlington, Iowa.

1910. *‡SANBORN, JOHN R. General Manager, The Automatic News Distributing Company, 1306 First National Bank Building, Cincinnati, O.

1912. SANDO, WILL J. Consulting Engineer, Milwaukee Club, Milwaukee, Wis.

1910. ‡SANGER, F. M., JR. Assistant Superintendent, Tyler Tube and Pipe Company, Washington, Pa.

1908. SARGENT, FITZ WILLIAM. Chief Engineer, American Brake-Shoe and Foundry Company, Box 15, Mahwah, N. J.

1910. *SARGENT, GEORGE W. Fourth Vice-President, Crucible Steel Company of America, Empire Building, Pittsburgh, Pa.

1902. *SAUNDERS, WALTER M. Analytical and Consulting Chemist, 184 Whittier Avenue, Providence, R. I.

1896. *SAUVEUR, ALBERT. Metallurgical Engineer; Professor of Metallurgy, Harvard University, Rotch Building, Cambridge, Mass.

1908. *SAWYER, ARTHUR HENRY. In charge of Cement Laboratory, The Hudson and Manhattan Railroad Company, Platform 6, 30 Church Street, New York, N. Y.

1903. SCARBOROUGH, F. W. Mining Engineer, 816 Mutual Building, Richmond, Va.

1904. SCHADE, G. C. 314 West College Street, Canonsburg, Pa.

1912. *SCHAEFFER, JOHN A. Chief Chemist, Picher Lead Company, Joplin, Mo.

1908. SCHALL, FREDERICK E. Bridge Engineer, Lehigh Valley Railroad Company, South Bethlehem, Pa.

1907. *SCHEIDEL, A. Managing Director, The Commonwealth Portland Cement Company, Mutual Life of New York Building, Martin Place, Sydney, Australia.

1909. SCHENECTADY VARNISH COMPANY. W. H. Wright, Schenectady, N. Y.

1908. *SCHILDHAUER, EDWARD. Electrical and Mechanical Engineer, Isthmian Canal Commission, Department of Construction and Engineering, Culebra, Canal Zone.

1908. SCHLUEDERBERG, GEORGE W. Coal Operator, 210 West Craig Street, Pittsburgh, Pa.

ELECTED.

1904. *SCHMITT, F. E. Associate Editor, *Engineering News*, 505 Pearl Street, New York, N. Y.

1905. SCHNEIDER, C. C. Consulting Engineer, Pennsylvania Building, Philadelphia, Pa.

1900. SCHNEIDER, HERMAN. Professor of Civil Engineering, University of Cincinnati, Cincinnati, O.

1906. SCHNELL, HARRY J. Editor and Manager, *Oil, Paint and Drug Reporter*, *The Druggists' Circular* and *The Painters' Magazine*, 100 William Street, New York, N. Y.

1905. *SCHNIEWIND, F. Consulting Chemical Engineer; Vice-President, The United Coke and Gas Company, 17 Battery Place, New York, N. Y.

1911. *SCHOOL OF MARINE ENGINEERING LIBRARY. M. E. Reed, Lieutenant-Commander, United States Navy, Head of School, United States Naval Academy, Annapolis, Md.

1910. SCHREIBER, MARTIN. Engineer, Maintenance of Way, Public Service Railway Company, Newark, N. J.

1909. SCHRODTER, E. Secretary, Verein Deutscher Eisenhüttenleute, Düsseldorf 74, 27 Breite Strasse, Germany.

1902. SCHUERMAN, W. H. Dean of Engineering Department and Professor of Civil Engineering, Vanderbilt University, Nashville, Tenn.

SCHUHMAN, GEORGE (see *Reading Iron Company*).

SCHULZE, HENRY H. (see *Fore River Shipbuilding Company*).

SCHUYLER, MONT (see *Testing Laboratory, City of St. Louis*).

1905. SCHWARTZ, ARCHIE W. Inspector, Bureau of Buildings, Borough of Manhattan, 80 East Washington Square, New York, N. Y.

1907. SCHWARTZ, HARRY A. Chemist, The National Malleable Castings Company. *For Mail:* 522 Tibbs Avenue, Indianapolis, Ind.

1911. *SCHWENDENER, KARL D. Assistant Inspector of Buildings, City of Los Angeles, 2062 West Twenty-seventh Street, Los Angeles, Cal.

1908. *SCOFIELD, H. H. Instructor in Testing Materials, Purdue University, Lafayette, Ind.

1910. *SCOTT, ARTHUR P. Metallurgist, Dominion Iron and Steel Company, Sydney, N. S.

SCOTT, D. G. (see *American Iron and Steel Manufacturing Company*).

ELECTED.

1911. SCOTT, ROBERT G., JR. Chief Order Clerk, American Sheet and Tin Plate Company, Vandergrift, Pa.

1904. *SCOTT, WILLIAM F. Structural Engineer, Dunnville, Canada.

1910. *‡SEABURY, RICHARD W. Secretary and Treasurer, Boonton Rubber Company, Box 423, Boonton, N. J.

1898. SEAMAN, HARRY J. Superintendent, Atlas Cement Company, Catasauqua, Pa.

1902. SEAMAN, HENRY B. Consulting Engineer, 165 Broadway, New York, N. Y.

1906. SEARS, W. T. Pratt and Whitney Company, Hartford, Conn.

1912. SEATTLE CONSTRUCTION AND DRY DOCK COMPANY. J V. Paterson, President and General Manager, Seattle, Wash

SELLERS, COLEMAN, JR. (see *William Sellers and Company, Incorporated*).

1910. SELLERS, JAMES C., JR. Standard Steel Works Company, Morris Building, Philadelphia, Pa.

1904. *SELLERS AND COMPANY, INCORPORATED, WILLIAM. Coleman Sellers, Jr., President, 1600 Hamilton Street, Philadelphia, Pa.

1910. *SELLEW, WILLIAM H. Principal Assistant Engineer, Michigan Central Railroad Company, Detroit, Mich.

1906. *SEMET-SOLVAY COMPANY. O. S. Doolittle, Sales Agent, 100 William Street, New York, N. Y.

1912. *SETZLER, H. B. General Superintendent, The National Refining Company, Coffeyville, Kan.

1910. *SEXTON, F. H. President, Nova Scotia Technical College, Halifax, Nova Scotia, Canada.

1911. ‡SHAFFER, CARLETON B. Shaffer and Mowry, 626 Seaboard Bank Building, Norfolk, Va.

1911. SHAFFER, GUY F. Draftsman with Cass Gilbert, 11 East Twenty-fourth Street, New York, N. Y.

1902. *SHANKLAND, E. C. AND R. M. Civil Engineers, 1106 The Rookery, Chicago, Ill.

1907. SHANNON, CHARLES. 617 Liberty Avenue, Pittsburgh, Pa.

1912. SHARON STEEL HOOP COMPANY. A. A. Keally, Assistant to President, Sharon, Pa.

SHARP, CLAYTON H. (see *Electrical Testing Laboratories*).

1909. SHARPLES, PHILIP P. Chemist, 297 Franklin Street. Boston, Mass.

ELECTED.

1911. SHEAFE, JAMES S. Engineer of Tests, Illinois Central Railroad Company, Burnside Shops, Chicago, Ill.

1911. SHEFFIELD SCIENTIFIC SCHOOL LIBRARY. L. P. Breckenridge, Professor of Mechanical Engineering, Mason Laboratory, New Haven, Conn.

1911. SHELDON AXLE COMPANY. William H. Son, Vice President and General Manager, Wilkes-Barre, Pa.

1910. SHEPARD, WILLIAM KENT. Instructor in Mechanics, Yale University, Mason Laboratory, New Haven, Conn.

1911. SHERMAN, C. W. General Manager, Pratt and Fetchworth Company, 189 Tonawanda Street, Buffalo, N. Y.

1904. SHERMAN, HERBERT L. Industrial and Engineering Chemist, 12 Pearl Street, Boston, Mass.

1906. SHERRERD, JOHN M. General Sales Agent, Taylor Iron and Steel Company, High Bridge, N. J.

1903. SHERRERD, MORRIS R. Engineer and Superintendent, Department of Water, City of Newark, 128 Halsey Street, Newark, N. J.

1902. SHERWIN-WILLIAMS COMPANY, THE. Paint and Varnish Makers. A. P. Johnstone, 100 Canal Street, Cleveland, O.

1912. ‡SHIELDS, JAMES RALPH. Assistant in Testing Laboratory, University of California, 2119 McKinley Avenue, Berkeley, Cal.

1899. *SHIMER, PORTER W. Chemist and Metallurgist, Easton, Pa.

SHOEMAKER, C. B. (see *Glasgow Iron Company*).

1910. SHOEMAKER, M. N. Vice-President and Treasurer, American Concrete-Steel Company, 718 Union Building, Newark, N. J.

1910. *SHORE, ALBERT F. President, Shore Instrument Company, 557 West Twenty-second Street, New York, N. Y.

1906. SHULTS, CHARLES. Salesman, Worth Brothers Company, 111 Broadway, New York, N. Y.

1902. *SHUMAN, JESSE J. Inspecting Engineer, Testing Department, Jones and Laughlin Steel Company, Pittsburgh, Pa.

1912. ‡SIBBALD, C. T. A. Civil Engineer, 769 Third Avenue North, Troy, N. Y.

1910. *‡SIMON, S. K. Superintendent, Alabama Portland Cement Company, Demopolis, Ala.

1912. SIMPSON, ALEXANDER, JR. Superintendent, Whitney-Steen Company, 720 Symes Building, Denver, Col.

ELECTED.

1911. ‡SIMPSON, TRACY W. Head of Works, Methods Bureau, Manufacturing Department, International Harvester Company, 249 Paris Avenue, Grand Rapids, Mich.

1912. SINKINSON, J. DAWSON. Chemist, National Lead Company, 900 West Eighteenth Street, Chicago, Ill.

SISE, EDWARD F. (see *Imperial Wire and Cable Company, Limited*).

1903. *SKINNER, C. E. (*Member of Executive Committee*). Electrical Engineer, Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.

1908. SKINNER, HERVEY J. Vice-President, Arthur D. Little, Incorporated, 93 Broad Street, Boston, Mass.

1904. *SKINNER, ORVILLE CAMPBELL. Assistant Superintendent, Standard Steel Works Company, Burnham, Pa.

1912. *SLATER, W. A. Assistant, Laboratory of Applied Mechanics, University of Illinois, Urbana, Ill.

1912. *SLOAN, ALFRED P., JR. General Manager, Hyatt Roller Bearing Company, Box 476, Newark, N. J.

1910. SLOCUM, CHARLES V. Special Agent, The Titanium Alloy Manufacturing Company, 5500 Irwin Avenue, Pittsburgh, Pa.

1908. *SLOCUM, FRANK S. Special Representative, Jones and Laughlin Steel Company, Pittsburgh, Pa.

SMITH, A. B. (see *Kansas State Agricultural College Library*).

SMITH, C. C. (see *Union Steel Casting Company*).

1907. SMITH, CHARLES E. Maintenance of Way Department, Missouri Pacific Railway Company, St. Louis, Mo.

1906. *SMITH, EMERY AND COMPANY. Chemists and Chemical Engineers, 651 Howard Street, San Francisco, Cal.

1906. *SMITH, E. B. In charge of Mechanical Laboratories, Drexel Institute, Thirty-second and Chestnut Streets, Philadelphia, Pa.

1907. SMITH, FRANCIS P. Chemical Engineer, 24–26 East Twenty-first Street, New York, N. Y.

1902. *SMITH, H. E. Chemist, The Lake Shore and Michigan Southern Railway Company, 36 Beersford Place, East Cleveland, O.

1910. SMITH, H. LE H. Chief of Testing Bureau, Brooklyn Rapid Transit Company, Kent and Division Streets, Brooklyn, N. Y.

1911. SMITH, J. HAMMOND. Professor of Civil Engineering, University of Pittsburgh, Pittsburgh, Pa.

ELECTED.

1908. SMITH, KERRY AND CHACE. Consulting and Constructing Engineers, 124-126 Confederation Life Building, Toronto, Canada.

1910. SMITH, LAWRENCE SOUTHWICK. Instructor in Mechanical Engineering, Massachusetts Institute of Technology, Boston, Mass.

1909. ‡SMITH, STUART. Chief Chemist, The Superior Portland Cement Company, Limited, Orangeville, Ontario, Canada.

SMITH, W. ACHESON (see *International Acheson Graphite Company*).

SMITH, WALTER M. (see *University of Wisconsin Library*).

SMOOT, A. M. (see *Ledoux and Company*).

1902. *SNOW, J. P. 1120 Kimball Building, Boston, Mass.

1908. SOCIETY OF GAS ENGINEERING OF NEW YORK. W. Cullen Morris, 4 Irving Place, New York, N. Y.

1909. *SOMMER, ALBERT. Consulting Chemist, The Barber Asphalt Paving Company, Land Title Building, Philadelphia, Pa.

1904. SOMMERVILLE, C. W. Architect, Union Trust Building, Washington, D. C.

SON, WILLIAM H. (see *Sheldon Axle Company*).

1903. *SOUTHER, HENRY. Consulting Metallurgical Engineer; State Chemist, 11 Laurel Street, Hartford, Conn.

1904. *SPACKMAN ENGINEERING COMPANY, HENRY S. 42 North Sixteenth Street, Philadelphia, Pa.

1905. SPALDING, F. P. Professor of Civil Engineering, University of Missouri, Columbia, Mo.

1905. *SPARE, C. R. Vice-President, American Manganese Bronze Company, Holmesburg, Philadelphia, Pa.

1906. SPARHAWK, GEORGE F. Engineer, American Bridge Company, Ambridge, Pa.

1910. *SPAULDING, RALPH E. With Aberthaw Construction Company, Boston, Mass. *For Mail:* Suffield, Conn.

SPELLER, FRANK N. (see *National Tube Company*).

1909. *SPENCER, HERBERT. Civil Engineer, 26 Broadway, New York, N. Y.

1911. ‡SPENGLER, J. H. 4357 Oakenwell Avenue, Chicago, Ill.

1912. ‡SPERLING, THOMAS G. Civil Engineer, 187 Seventh Street, Elmhurst, New York, N. Y.

ELECTED.

1909. *SPERRY, EDWIN S. Metallurgist, *The Brass World*, 260 John Street, Bridgeport, Conn.

1912. *‡SPERRY, F. L. Inspector, Pittsburgh Testing Laboratory, 305 Praetorian Building, Dallas, Tex.

1901. SPERRY, W. L. President and Manager, The Cumberland Hydraulic Cement and Manufacturing Company, Box 264, Cumberland, Md.

1906. SPRAGUE, L. G. Chemist, Virginia Portland Cement Company, Fordwick, Va.

1911. *STACKS, D. H. Technical Investigator, Deere and Company, Moline, Ill.

1912. *STAFFORD, B. E. D. General Manager, Flannery Bolt Company, Frick Building, Pittsburgh, Pa.

1908. STAFFORD, C. EDWARD. Union League, Philadelphia, Pa.

1909. *STAFFORD, SAMUEL G. Vice-President and General Manager, Vulcan Crucible Steel Company, Alequippa, Pa.

1908. STANDARD ASPHALT AND RUBBER COMPANY. W. L. Levering, Treasurer, 205 La Salle Street, Chicago, Ill.

1908. STANDARD SCREW COMPANY. E. H. Ehrman, Secretary and Factory Manager, Chicago Screw Company, 1026 South Homan Avenue, Chicago, Ill.

1902. *STANDARD STEEL WORKS COMPANY. William Vollmer, Superintendent, Burnham, Pa.

1909. STANDARD UNDERGROUND CABLE COMPANY. C. C. Baldwin, Superintendent, Wire and Rod Mill, Perth Amboy, N. J.

1910. STANFORD UNIVERSITY, LELAND, JUNIOR. G. T. Clark, Librarian, Stanford University, Cal.

1905. STANGER, R. H. HARRY. Consulting Engineer, Testing Works and Chemical Laboratories, 2 Broadway, Westminster, London, S. W., England.

1907. *STANSFIELD, ALFRED. Professor of Metallurgy, McGill University, Montreal, Canada.

1903. STAPLETON, F. M. Mechanical Inspector, Erie Railroad Company, 614 Thompson Street, Pittsburgh, Pa.

1910. STARR, JOHN J. Secretary, The Robinson Clay Products Company, Akron, O.

1907. STATE GEOLOGICAL SURVEY. H. F. Bain, Director, Urbana, Ill.

1912. *STERNBERG, KURT R. Treasurer and General Manager, Dickinson Manufacturing Co., Springfield, Mass.

ELECTED.

1896. *STEVENSON, A. A. (*Member of Executive Committee*). Vice-President, Standard Steel Works Company, Morris Building, Philadelphia, Pa.

STEVENSON, J. S. (see *Berry Brothers, Limited*).

1911. STEWART, JOHN T. Professor of Agricultural Engineering, University of Minnesota, University Farms, St. Paul, Minn.

1909. STEWART, L. C. General Manager, Virginia Metal Culvert Company, Roanoke, Va.

1906. STILLMAN, HOWARD. Mechanical Engineer and Engineer of Tests, Southern Pacific Company, 2430 Piedmont Avenue, Berkeley, Cal.

1899. *STILLMAN, THOMAS B. Professor of Chemistry, Stevens Institute of Technology, Hoboken, N. J.

1909. *STODDARD, RAYMOND FRENCH. Consulting Engineer, 83 Fairfield Avenue, Bridgeport, Conn.

1910. STONE, GEORGE C. Metallurgist, New Jersey Zinc Company, 55 Wall Street, New York, N. Y.

STONECIPHER, J. F. (see *Lafayette College Library*).

1903. STOREY, W. B., JR. Vice-President, Atchison, Topeka and Sante Fé Railroad Company, 1033 Railway Exchange Building, Chicago, Ill.

1912. STORM, W. H. Supervisor of Forms, Isthmian Canal Commission, Gatun, Canal Zone

1906. STORRS, L. S. Vice-President, The Connecticut Company, New Haven, Conn.

1902. *STOUGHTON, BRADLEY. Metallurgist, 165 Broadway, New York, N. Y.

1910. STRACHAN, ROBERT C. Assistant Engineer, Department of Bridges, City of New York. *For Mail:* 371 Grant Avenue, Richmond Hill, N. Y.

1911. *STRANGE, WILLIAM WALLACE. Chemist, Box 151, Pony, Mont.

1907. STRATTON, S. W. (*Member of Executive Committee*). Director, United States Bureau of Standards, Washington, D. C.

1912. ‡STREET, JOHN Z. Civil Engineer, 82 Fourth Avenue, Troy, N. Y.

1909. *STRICKLER, G. B. President, Southern Sand and Gravel Company, Fredericksburg, Va.

1896. STROBEL, CHARLES L. Consulting Engineer, 1744 Monadnock Block, Chicago, Ill.

ELECTED.

1908. Strong, Robert M. Care of Mallinckrodt Chemical Works, St. Louis, Mo.

1910. *Studebaker Corporation. Reference Department, South Bend, Ind.

1904. *Stuetz, Ernest. 437 Fifth Avenue, New York, N. Y.

1909. Sumner, Warren E. Chemist, Box 13, East Walpole, Mass.

1906. Suydam, Richard S. President, M. B. Suydam Paint Company, Pittsburgh, Pa.

1896. *Swain, George F. Professor of Civil Engineering, Graduate School of Applied Science, Harvard University, Pierce Hall, Oxford Street, Cambridge, Mass.

1903. Swanberg, F. L. Secretary, The D. T. Williams Valve Company, 904–910 Broadway, Cincinnati, O.

1910. Sweetser, E. O. Assistant Professor of Civil Engineering, Washington University, St. Louis, Mo.

1903. *Swensson, Emil. Consulting Engineer, Frick Building, Pittsburgh, Pa.

1908. Switzer, John A. Assistant Professor of Experimental Engineering, University of Tennessee, Knoxville, Tenn.

1905. *Taber, George H. General Manager, Gulf Refining Company, Frick Building, Pittsburgh, Pa.

1903. Taggart, Howard. Engineer of Tests, Lukens Iron and Steel Company, Box 632, Coatesville, Pa.

1898. *Talbot, Arthur N. (*Second Vice-President.*) Professor of Municipal and Sanitary Engineering, University of Illinois, Urbana, Ill.

1902. Talbot, Henry P. Professor of Inorganic and Analytica Chemistry, Massachusetts Institute of Technology, Boston, Mass.

1904. Tassin, Wirt. With Duplex Metals Company, Chester, Pa.

1909. *‡Taylor, C. Marshall. Superintendent, Tie Treating Plant, Philadelphia and Reading Railway Company, Philadelphia, Pa.

1908. Taylor, John. Superintendent, Continental Portland Cement Company, St. Louis, Mo.

1908. Taylor, John O. 311 Daniel Street, Champaign, Ill.

1906. *Taylor, Knox. President, Taylor Iron and Steel Company, High Bridge, N. J.

1900. Taylor, William Purves. Engineer in charge, Testing Laboratory, 232 City Hall, Philadelphia, Pa.

1912. Tchorni, D. L. Chemist, Gibbsboro, N. J.

ELECTED.

1896. *TECHNISCHER VEREIN, NEW YORK. Carl Kaelble, Secretary, Room 719, Engineering Building, 29 West Thirty-ninth Street, New York, N. Y.

1911. *TEFFT, G. H. Secretary and Sales Manager, W. S. Dickey Clay Manufacturing Company, 200 New York Life Building, Kansas City, Mo.

1910. *TESTING LABORATORY, CITY OF ST. LOUIS. Mont Schuyler, Engineer-in-Charge, Kingshighway and Eager Road, St. Louis, Mo.

1910. TEXTOR, OSCAR. Analytical and Consulting Chemist, 603 Superior Avenue, N. W., Cleveland, O.

1902. THACHER, EDWIN. Consulting Engineer; Member, Concrete-Steel Engineering Company, Park Row Building, New York, N. Y.

1912. ‡THACHER, S. P. Assistant Superintendent and Chemist, New Jersey Car Spring and Rubber Company, Jersey City, N. J.

THACKRAY, GEORGE E. (see *Cambria Steel Company*).

1900. *THOMAS, DAVID. Logan Iron and Steel Company, Burnham, Pa.

1908. THOMAS, GEORGE, 3D. Treasurer, Parkesburg Iron Company, Parkesburg, Pa.

1911. THOMAS, H. C. Assistant General Superintendent, Gary Works, Indiana Steel Company, 712 Jackson Street, Gary, Ind.

1906. ‡THOMPSON, G. SAXTON. Assistant in Mechanics, Rensselaer Polytechnic Institute, 689 Second Avenue, Troy, N. Y.

1903. *THOMPSON, GUSTAVE W. Chemist, National Lead Company, 129 York Street, Brooklyn, N. Y.

1905. *THOMPSON, HUGH L. Consulting Engineer, Waterbury, Conn.

1907. *THOMPSON, JOHN FAIRFIELD. Chief of Testing Department, The Orford Copper Company, New Brighton, Staten Island, N. Y.

1904. *THOMPSON, SANFORD E. Civil Engineer, Newton Highlands, Mass.

1908. THOMSON, REGINALD H. Chief Engineer, Seattle Port Commission, Central Building, Seattle, Wash.

1911. THORPE, J. B. Chief Chemist, Gary Works, Indiana Steel Company, Box 614, Gary, Ind.

1908. ‡TIBBETTS, FRED W. Civil Engineer, Alaska Commercial Building, San Francisco, Cal.

ELECTED.

1910. *Tiemann, Hugh P. Metallurgist, Carnegie Steel Company, Pittsburgh, Pa.

1908. Tilt, Edwin B. Engineer of Tests, Canadian Pacific Railway Company, 4278 Western Avenue, Westmount, Canada.

1912. Tilton, Henry B. Superintendent, The Laconia Car Company's Works, Laconia, N. H.

1909. Tinker, George H. Bridge Engineer, New York, Cincinnati and St. Louis Railway, 420 Hickok Building, Cleveland, O.

1912. Tinsley, John F. Superintendent, South Works, American Steel and Wire Company, Worcester, Mass.

1908. ‡Tissing, David. Assistant Chemist, Northern Pacific Railway Company, General Office Building, St. Paul, Minn.

1910. Titanium-Alloy Manufacturing Company, The. Harry H. Cook, District Agent, 1845 Peoples Gas Building, Chicago, Ill.

1903. *Toch, Maximilian. Paint Manufacturer, 320 Fifth Avenue, New York, N. Y.

1903. Tomkins, Calvin. Commissioner of Docks and Ferries, Pier A, North River, New York, N. Y.

1903. Touceda, Enrique. Chémist and Metallurgist, 51 State Street, Albany, N. Y.

1912. *Towne, Thomas. Eastern Manager, New York State Steel Company and Union Drawn Steel Company, 460 Washington Street, New York, N. Y.

1906. Trautwein, A. P. President, Carbondale Instrument Company, Carbondale, Pa.

1907. *Trautwine, John C., Jr. Civil Engineer, 257 South Fourth Street, Philadelphia, Pa.

Treat, R. B. (see *Crocker-Wheeler Company*).

1906. Tretch, William J. Superintendent, Riehlé Brothers Testing Machine Company, 1424 North Ninth Street, Philadelphia, Pa.

1912. ‡Trevino, Virgilis. Civil Engineer, Aportado 11, Torreon Coah., Mexico.

1905. *Trist, N. B. With Carnegie Steel Company, Fifth Avenue, Pittsburgh, Pa.

1904. Trooien, O. N. Mechanical Engineer, 3007 Portland Avenue, Minneapolis, Minn.

1910. *Trow, Charles A. Chief Engineer, California Midland Railroad, Marysville, Cal.

ELECTED.

1912. ‡TSANG, LEM. SEC. Civil Engineer, 201 Eighth Avenue, Troy, N. Y.

1908. *TUCKER, HERMAN FRANKLIN. 60 Greenough Street, Brookline, Mass.

1904. TUFTS COLLEGE, DEPARTMENT OF ENGINEERING. Gardner C. Anthony, Dean, Tufts College, Mass.

1909. *TULANE UNIVERSITY, DEPARTMENT OF EXPERIMENTAL ENGINEERING. Professor W. B. Gregory, New Orleans, La.

1902. *TURNEAURE, F. E. Dean of the College of Mechanics and Engineering, University of Wisconsin, Madison, Wis.

1906. *TURNER, HENRY C. President, Turner Construction Company, 11 Broadway, New York, N. Y.

1912. TURNER, H. S. Superintendent, Chicago Portland Cement Company, Oglesby, Ill.

1910. TYLER COMPANY, W. S. M. P. Reynolds, Sales Manager, Cleveland, O.

1912. *UHLER, J. LLOYD. Metallurgist, Union Stee Castings Company, Sixty-first and Butler Streets, Pittsburgh, Pa.

1909. *UNGER, J. S. Manager, Central Research Laboratory, Carnegie Steel Company, Duquesne, Pa.

1908. *UNION DRAWN STEEL COMPANY. F. N. Beegle, President, Beaver Falls, Pa.

1907. UNION STEEL CASTING COMPANY. C. C. Smith, President, Sixty-first and Butler Streets, Pittsburgh, Pa.

1908. UNITED GAS IMPROVEMENT COMPANY. W. H. Gartley, Engineer of Works (Philadelphia Gas Works), Twenty-third and Filbert Streets, Philadelphia, Pa.

1908. UNITED STATES CAST IRON PIPE AND FOUNDRY COMPANY. N. F. S. Russell, Eastern Sales Manager, Morris Building, Philadelphia, Pa.

1907. *UNITED STATES GUTTA PERCHA PAINT COMPANY. Herbert W. Rice, Secretary, Providence, R. I.

1911. UNITED STATES GYPSUM COMPANY. S. G. Webb, 200 Monroe Street, Chicago, Ill.

1911. UNITED STATES SHERARDIZING COMPANY. Thomas Liggett, Jr., Assistant to President, New Castle, Pa.

1906. UNIVERSITY OF KANSAS, SCHOOL OF ENGINEERING. F. O. Marvin, Dean, Lawrence, Kan.

1911. UNIVERSITY OF NEVADA LIBRARY. J. D. Layman, Librarian, Reno, Nev.

ELECTED.

1910. University of North Dakota. Charles H. Compton, Librarian, University, N. D.

1912. *University of Wisconsin Library. Walter M. Smith, Librarian, Madison, Wis.

Upson, Maxwell M. (see *Raymond Concrete Pile Company*).

1906. Vandevort, F. F. Iron and Steel Agent, 66 Broadway, New York, N. Y.

1903. Van Gundy, C. P. Chief Chemist, Baltimore and Ohio Railroad Company, Mont Clare, Baltimore, Md.

1902. *Van Ornum, J. L. Professor of Civil Engineering, Washington University, St. Louis, Mo.

1909. ‡Van Trump, Isaac. Chief Chemist, The American Asphalt Paving Company, 2337 South Paulina Street, Chicago, Ill.

1908. ‡Vauclain, Jacques L. Engineer of Tests, Baldwin Locomotive Works, 500 North Broad Street, Philadelphia, Pa.

1908. Veitch, F. Chief Chemist, Leather and Paper Laboratory, Bureau of Chemistry, Department of Agriculture, Washington, D. C.

1910. Verity, R. H. General Superintendent, Massey-Harris Company, Limited, Toronto, Canada.

1909. Vial, F. K. Construction Engineer, Griffin Wheel Company, Sacramento Square, Chicago, Ill.

1909. *Viele, Blackwell and Buck. Consulting Engineers, 49 Wall Street, New York, N. Y.

1896. Vogt, A. S. Mechanical Engineer, Pennsylvania Railroad Company, Altoona, Pa.

1907. Voight, M. L. Superintendent of Shops, Borden's Condensed Milk Company, 952 De Kalb Avenue, Brooklyn, N. Y.

Vollmer, William (see *Standard Steel Works Company*).

1903. *Von Schrenk, Hermann. Von Schrenk, Fulks and Kammerer, Consulting Timber Engineers, Tower Grove and Fled Avenue, St. Louis, Mo.

1902. *Voorhees, S. S. Engineer-Chemist, Bureau of Standards, Washington, D. C.

1903. *Vredenburgh, Watson, Jr. Member, Hildreth and Company, Engineers, 17 Battery Place, New York, N. Y.

ELECTED.

1909. WACLARK WIRE COMPANY. F. W. Wallace, Treasurer, 49 Wall Street, New York, N. Y.

1896. *WADDELL, J. A. L. Consulting Civil Engineer, 1012 Baltimore Avenue, Kansas City, Mo.

1908. WADLEIGH, F. R. Assistant General Manager, Chesapeake and Ohio Coal and Coke Company, Muncey Building, Washington, D. C.

WADSWORTH, G. K. (see *The Peerless Motor Car Company*).

1907. WADSWORTH, J. E. Resident Engineer, American Bridge Company, Hudson Terminal, 30 Church Street, New York, N. Y.

1904. WAGENHORST, JAMES H. General Manager, The United Rim Company, Akron, O.

1912. ‡WAGNER, C. L. Chief Chemist, Superior Portland Cement Company, Concrete, Wash.

1910. WAGNER, JOHN M. Purchasing Agent, Copper Range Railroad Company, Box 30, Houghton Mich.

1899. *WAGNER, SAMUEL TOBIAS. Assistant Engineer, Philadelphia and Reading Railway Company, Huntingdon Street Station, Philadelphia, Pa.

1903. *WAID, D. EVERETT. Architect, Madison Avenue, New York, N. Y.

1904. WALDO BROTHERS. 102 Milk Street, Boston, Mass.

1910. *WALDO, LEONARD. Consulting Engineer, 49 Wall Street, New York, N. Y.

1910. WALKER, H. F. Engineer of Tests, Standard Steel Works Company, Box 598, Burnham, Pa.

1912. ‡WALKER, MELVILLE ASAPH. Civil Engineer, Westport, N. Y.

1907. WALKER, PERCY H. Chief Chemist, Contracts Laboratory, Bureau of Chemistry, Washington, D. C.

1905. WALKER, WILLIAM H. Professor of Industrial Chemistry, Massachusetts Institute of Technology, 24 Trinity Place, Boston, Mass.

1910. *WALKER, W. R. Assistant to President, United States Steel Corporation, 71 Broadway, New York, N. Y.

1904. *WALLACE, E. C. 306 South Street, Jamaica Plains, Mass.

WALLACE, F. W. (see *Waclark Wire Company*).

1910. WALLACE, JOHN T. Vice-President, Blackmer and Post Pipe Company, 613 Wainwright Building, St. Louis, Mo.

1910. ‡WALLEDOM, JESSE J. 6717 Perry Avenue, Chicago, Ill.

ELECTED.

1912. *WALLIS, J. T. General Superintendent of Motive Power, Pennsylvania Railroad Company, Altoona, Pa.

1903. *WALTER, LEE W. Cement Inspector, Erie Railroad Company, Ninth and Provost Streets, Jersey City, N. J.

1908. WALTERS, HARRY E. Metallurgical Chemist, Lincoln Foundry Company, Sixtieth and Butler Streets, Pittsburgh, Pa.

1912. WARE, E. E. Instructor in Chemical Engineering, University of Michigan, 808 Packard Street, Ann Arbor, Mich.

1912. WARNER, CHARLES. First Vice-President, Charles Warner Company, Wilmington, Del.

1903. WARNER, GEORGE C. Sullivan Machinery Company, Box 33, Claremont, N. H.

1905. WARREN BROTHERS COMPANY. 93 Federal Street, Boston, Mass.

1912. ‡WARWICK, C. LAURENCE. Instructor in Civil Engineering, University of Pennsylvania, Philadelphia, Pa.

1907. WASHBURN, FRANK E. Civil Engineer, Missouri Valley Bridge and Iron Company, Leavenworth, Kan.

1904. *WASON, LEONARD C. President, Aberthaw Construction Company, 8 Beacon Street, Boston, Mass.

1911. WATERBURY, LESLIE A. Professor of Civil Engineering, University of Arizona, Tucson, Ariz.

1912. *WATT, J. H. Chief Chemist, Pittsburgh Steel Company, Monesson, Pa.

WEBB, S. G. (see *United States Gypsum Company*).

1910. *‡WEBER, PETER J. City Chemist, City Hall, Milwaukee, Wis.

1900. *WEBSTER, GEORGE S. Chief Engineer and Surveyor, Bureau of Surveys, 318 City Hall, Philadelphia, Pa.

1898. *WEBSTER, WILLIAM R. Civil Engineer, 411 Walnut Street, Philadelphia, Pa.

1909. *WEBSTER, WILLIAM R. General Superintendent, Bridgeport Brass Company, Bridgeport, Conn.

1900. *WEEKS, PAUL. Mechanical Engineer, 216 Central Building, Los Angeles, Cal.

1910. WEIL, I. Consulting Engineer, Farmers' Bank Building, Pittsburgh, Pa.

1912. WELLS, GEORGE M. Office Engineer, Isthmian Canal Commission, Gatun, Canal Zone.

ELECTED.

1912. *WELLS, WALTER F. Assistant General Manager, Edison Electric Illuminating Company, 360 Pearl Street, Brooklyn, N. Y.

WEMLINGER, J. R. (see *American Society of Engineering Contractors*).

1904. WENTWORTH, CHARLES C. Principal Assistant Engineer, Norfolk and Western Railway Company, Roanoke, Va.

1905. WENTZ, DANIEL B. President, Stonega Coal and Coke Company, 1723 Land Title Building, Philadelphia, Pa.

1897. *WEST, THOMAS D. Foundry Expert, The West Steel Casting Company, 805 East Seventieth Street, Cleveland, O.

1912. WEST PENN TRACTION COMPANY. W. E. Moore, Manager, Bank of Savings Building, Pittsburgh, Pa.

1909. *WESTERN ELECTRIC COMPANY. G. Crossman, in charge of Inspection Branch Engineering Department, 463 West Street, New York, N. Y.

1910. WESTERN UNION TELEGRAPH COMPANY. R. E. Chetwood, Engineer of Construction, 195 Broadway, New York, N. Y.

1911. WESTESSEN, JOSEPH. Chemist, Naval Gun Factory, United States Navy Yard, Washington, D. C.

1909. *WESTINGHOUSE AIR BRAKE COMPANY. Harry C. Loudenbeck, Chief Chemist, Wilmerding, Pa.

1908. WESTINGHOUSE, CHURCH, KERR AND COMPANY. C. M. Chapman, Engineer-in-Charge, 10 Bridge Street, New York, N. Y.

1904. WESTINGHOUSE ELECTRIC AND MANUFACTURING COMPANY. L. A. Osborne, Vice-President, Box 911, Pittsburgh, Pa.

1907. WESTON, FREDERICK W. Standard Steel Works Company, 1982 Hudson Terminal Building, New York, N. Y.

1908. WEST VIRGINIA UNIVERSITY LIBRARY. Nathaniel L. Goodrich, Librarian, Morgantown, W. Va.

1910. WETHERILL, C. T. President, G. D. Wetherill and Company, 114 North Front Street, Philadelphia, Pa.

1911. WETHERILL, SAMUEL. Special Representative, C. M. Childs and Company, 99 John Street, New York, N. Y.

1906. WETTACH, CHARLES D. Secretary, W. W. Lawrence and Company, West Carson Street, Pittsburgh, Pa.

1907. *‡WEYMOUTH, FREDERICK A. Engineer of Tests, Maryland Steel Company, Sparrows Point, Md.

ELECTED.

1906. WHEELER, EDWARD J. Consulting Chemist, 79 Chapel Street, Albany, N. Y.

1912 WHEELWRIGHT, THOMAS S. Vice-President and General Manager, Old Dominion Iron and Nail Works Company, Richmond, Va.

1905. WHINERY, S. Consulting Engineer on Pavements, Borough of Manhattan, 95 Liberty Street, New York, N. Y.

1912. WHIPPLE, DORRIS. Consulting Chemical Engineer, 114 Liberty Street, New York, N. Y.

1908. WHIPPLE, GEORGE C. Consulting Engineer, 103 Park Avenue, New York, N. Y.

1909. *WHITE, ALFRED H. Professor of Chemical Engineering, University of Michigan, 933 Forrest Avenue, Ann Arbor, Mich.

1911. ‡WHITE, G. A. Superintendent, Electrical Laboratory, 155 Grant Avenue, Vandergrift, Pa.

1906. *WHITE, G. D. Manager, Patton Paint Company, Newark, N. J.

1909. WHITE AND COMPANY, J. G. C. D. Gray, Assistant Electrical Engineer, 43 Exchange Place, New York, N. Y.

1911. WHITE DENTAL MANUFACTURING COMPANY, THE S. S. W. A. Johnston, Factory Manager, Prince Bay, N. Y.

1909. *‡WHITEHEAD, ALLEN O. Assistant Manager, The Whitehead Iron and Steel Company, Tredegar, Monmouthshire, England.

1911. ‡WHITMAN, HARRY G. Chemist, Carpenter and Anderson, 19 Kellogg Street, Grand Rapids, Mich

1911. WHITTEMORE, H. L. Fayerweather Hall, Columbia University, New York, N. Y.

1898. *WICKHORST, MAX H. Engineer of Tests, Rail Committee, American Railway Engineering Association, 1011 Karpen Building, 910 South Michigan Avenue, Chicago, Ill.

1908. WIDDICOMBE, R. A. Engineer, 5552 Lakewood Avenue, Edgewater Station, Chicago, Ill.

1906. WIELAND, CHARLES F. Consulting Engineer, 911 Mutual Saving Bank Building, San Francisco, Cal.

1911. WIESE, H. B. Purchasing Agent, Parkesburg Iron Company, Parkesburg, Pa.

1909. *‡WIG, RUDOLPH J. Assistant Engineer, United States Geological Survey, Bureau of Standards, Washington, D. C.

ELECTED.

1909. *WIGHT, FRANK C. Associate Editor, *Engineering News*, 505 Pearl Street, New York, N. Y.

1910. *WILEY, CLARENCE N. Chief Chemist, Atlantic and Gulf Portland Cement Company, Drawer 111, Ragland, Ala.

1910. WILEY, W. O. Secretary, John Wiley and Sons, 43 East Nineteenth Street, New York, N. Y.

1902. WILHELM COMPANY, THE A. Paint Makers. Walter S. Davis, Secretary and Treasurer, Reading, Pa.

1898. WILLE, H. V. Assistant to General Superintendent, Baldwin Locomotive Works, 500 North Broad Street, Philadelphia, Pa.

1908. ‡WILLIAMS, C. C. Assistant Professor of Civil Engineering, University of Colorado, 1313 Seventh Street, Boulder, Colo.

1912. ‡WILLIAMS, HARRY M. Chemist, 1 Great Miami Boulevard, Dayton, O.

1908. WILLIAMS, HENRY J. Chemical Engineer, 161 Tremont Street, Boston, Mass.

1905. WILLIAMSON, SYDNEY B. Division Engineer, Pacific Division, Isthmian Canal Commission, Corozal, Canal Zone.

WILSON, E. B. (see *American Bureau of Inspection and Tests*).

1906. WILSON, EDWARD F. Chemist, Westmoreland Coal Company, Irwin, Pa.

1912. *WILSON, H. M. Engineer in Charge, Bureau of Mines, Pittsburgh, Pa.

1908. WILSON, PERCY H. Secretary, Association of American Portland Cement Manufacturers, 1232 Land Title Building, Philadelphia, Pa.

1906. *WINCHESTER REPEATING ARMS COMPANY. R. L. Penney, in charge of Physical Laboratory, New Haven, Conn.

1900. *WING, CHARLES B. Professor of Structural Engineering, Leland Stanford Junior University, Stanford University, Cal.

WINSLOW, R. S. (see *Clearfield Clay Working Company*).

WINSOR, PAUL (see *Boston Elevated Railway Company*).

1909. *‡WINT, RUFUS W. G. Chemist, F. W. Wint Company, Limited, Catasauqua, Pa.

1907. ‡WITHEY, MORTON OWEN. Assistant Professor of Mechanics, University of Wisconsin. *For Mail:* 1630 Madison Street, Madison, Wis.

ELECTED.

1910. Witmer, Francis P. Engineer in charge of Bridge Design, American Bridge Company, 30 Church Street, New York, N. Y.

1906. Wolf, Otto C. Engineer and Architect, 511 Denckla Building, Philadelphia, Pa.

1903. *Wolfel, Paul L. Chief Engineer, McClintic-Marshall Construction Company, Rankin, Pa.

1908. Wood, Alan, 3d. Mechanical Engineer, Conshohocken, Pa.

1903. Wood, Edward R., Jr. Manufacturer, 400 Chestnut Street, Philadelphia, Pa.

1910. Wood, Edwin T. Engineer of Tests, La Belle Iron Works, Steubenville, O.

1911. *‡Wood, F. B. Engineer of Tests, Standard Roller Bearing Company, Fifty-fifth Street and Lancaster Avenue, Philadelphia, Pa.

1903. Wood, F. W. President, Maryland Steel Company, Sparrows Point, Md.

1902. *Wood and Company, R. D. Founders. Walter Wood, 400 Chestnut Street, Philadelphia, Pa.

Wood, John G. (see *International Harvester Company*).

1900. *Wood, Walter. Cast-Iron Pipe Manufacturer, R. D. Wood and Company, 400 Chestnut Street, Philadelphia, Pa.

1910. ‡Woodroffe, G. H. Assistant Engineer of Tests, Baldwin Locomotive Works, 1 West Johnson Street, Germantown, Philadelphia, Pa.

Woods, C. F. (see *A. D. Little, Incorporated*).

1911. Woods, Fred L. Superintendent, Iola Portland Cement Company, Dewey, Okl.

1906. Woods, R. M. Chief Chemist, Northern Pacific Railway Company, General Office Building, St. Paul, Minn.

1906. Woodwell, Julian E. Consulting Engineer, Terminal Building, Park Avenue and Forty-first Street, New York, N. Y.

1908. Woodworth, R. B. Engineer with Carnegie Steel Company, 427 Carnegie Building, Pittsburgh, Pa.

1900. *Woolson, Ira H. Consulting Engineer, National Board of Fire Underwriters, 135 Williams Street, New York, N. Y.

1904. *Worcester, Joseph R. J. R. Worcester and Company, 79 Milk Street, Boston, Mass.

ELECTED.

1905. WORCESTER POLYTECHNIC INSTITUTE. William W. Bird, Director of the Department of Mechanical Engineering, Worcester, Mass.

1904. WORMELEY, P. L., JR. Engineer of Tests, Division of Tests, United States Department of Agriculture, 3014 Dent Place, Washington, D. C.

1912. WORTH BROTHERS COMPANY. James L. Hughes, Engineer of Tests, Coatesville, Pa.

WRIGHT, W. H. (see *Schenectady Varnish Company*).

1909. WULFETUNGE, J. F. Purchasing Agent, Riter-Conley Manufacturing Company, Pittsburgh, Pa.

1910. WYER, M. G. Librarian, State University of Iowa, Iowa City, Iowa.

1906. *WYMAN AND GORDON COMPANY, THE. George F. Fuller, General Superintendent and Secretary, Worcester, Mass.

1912. YATES, WILLIAM HENRY. Supervising Engineer, New York State Barge Canal, 84 Willett Street, Albany, N. Y.

1909. *YAMAGUCHI, JUNNOSUKE. Superintendent, Eastern Division Imperial Government Railways of Japan, Uyeno, Tokio, Japan.

1910. ‡YEOMAN, RAY C. Professor of Civil Engineering, Valparaiso University, Box 274, Valparaiso, Ind.

1911. YEOMANS, LUCIEN I. Production Engineer, Sears, Roebuck and Company, Chicago, Ill.

1911. *YOUNG, C. D. Engineer of Tests, Pennsylvania Railroad Company, Altoona, Pa.

1907. YOUNG, J. BERTRAM. Chemist, Philadelphia and Reading Railway Company, Reading, Pa.

1908. YOUNG, JOHN M. Dean of Engineering, University of Hawaii, Honolulu, T. H.

1905. YOUNG, JOHN P. General Manager, Youngstown Car Manufacturing Company, Youngstown, O.

1911. ‡YOUNG, ROBERT J. Assistant, Metallurgical Laboratory, Taylor Iron and Steel Company, Box 7, High Bridge, N. J.

1908. *†YOUNG, W. W. Consulting Engineer, 220 Broadway, New York, N. Y.

1907. *YOUNGSTOWN SHEET AND TUBE COMPANY. E. T. McCleary, Chief Chemist, Youngstown, O.

ELECTED.

1903. Zehnder, C. H. President, Alleghany Ore and Iron Company, 140 Cedar Street, New York, N. Y.

1911. *Zimmerschied, K. W. Metallurgical Engineer, General Motors Company, Detroit, Mich.

1908. *Zuercher, Max A. Assistant Engineer, in charge of Rail, Switch and Frog Work, Canadian Pacific Railway, 4 Norwood Avenue, Ahuntsic Ward, Montreal, Canada.

SUMMARY.

Total Membership	1,522
Total number holding membership also in the International Association for Testing Materials	598
Life Members	1
Memberships in Perpetuity	5
Junior Members	194

DECEASED MEMBERS.

Name.	Date of Membership.	Date of Death.
ALLIEN, VICTOR S.	1906	February 1, 1908.
ANDERSON J. W.	1896	May 18, 1905.
ATKINSON EDWARD,	1903	December 11,1905.
ATKINSON, JOHN B.	1908	September 21, 1912.
AUSTEN, P. T.	1906	December 30, 1907.
BALDWIN, S. W.	1904	January 5, 1910.
BARNSLEY, G. T.	1904	October 23, 1909.
BLACK, W. P.	1896	December 12, 1902.
BUCKLEY, E. R.	1903	January 19, 1912.
BUDD, HENRY I.	1903	January 14, 1905.
CHRISTIE, JAMES	1898	August 24, 1912.
DERBY, W. A.	1910	June 30, 1912.
DROWN, THOMAS M.	1899	November 16, 1904.
DUDLEY, CHARLES B.	1896	December 21, 1909.
FRANKEL, HENRY U.	1903	December 8, 1903.
GOWEN, CHARLES S.	1904	October 19, 1909.
GRAY, THOMAS	1896	February 12, 1909.
HALLETT, NELSON A.	1903	August 9, 1910.
HANCOCK, E. L.	1903	October 1, 1912.
HINCKLEY, J. F.	1907	February 19, 1911.
HOBBS, F. E.	1906	April 12, 1911.
HOOPER, A.	1908	December 28, 1909.
JARECKI, CHARLES	1896	January 26, 1901.
JOHNSON, EDMUND	1905	May 23, 1909.
JOHNSON, J. B.	1899	June 23, 1902.
JOHNSON, W. C.	1900	December 15, 1906.
KERNS, JOHN J.	1910	March 12, 1911.
LUDLOW, S. H.	1904	January 16, 1908.
MATCHAM, CHARLES A.	1902	September 22, 1912.
MCCAULEY, G. M.	1898	May 25, 1901.
METCALF, WILLIAM	1903	December 5, 1009.
MORISON, GEORGE S.	1896	July 1, 1903.
MORTON, HENRY	1896	May 9, 1902.
MOULTON, MACE	1906	April 27, 1909.
NEWSOME, EDGAR T.	1911	February 6, 1912.
PIERCE, D. H.	1907	July 1, 1909.
SPANGLER, H. W.	1902	March 17, 1912.
TATNALL, GEORGE	1906	September 13, 1906.
TAUBENHEIM, ULRICH E.	1904	December 19, 1911.
THURSTON, ROBERT H.	1896	October 25, 1903.
WARMAN, F. C.	1905	April 27, 1908.
WOODMAN, D.	1903	September 4, 1907.
WRIGHT, H. H.	1904	June 22, 1905.
WYMANN, W. H.	1905	November 11, 1905.

GEOGRAPHICAL DISTRIBUTION OF MEMBERS.

ALABAMA.

Birmingham: A. W. Allen; F. H. Crockard; J. R. Harris.
Demopolis: S. K. Simon.
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Ragland: C. N. Wiley.
St. Stephens: O. Gerlach.
University: E. B. Kay.

ARIZONA.

Tucson: L. A. Waterbury.

CALIFORNIA.

Berkeley: A. C. Alvarez; P. F. Bovard; C. Derleth, Jr.; C. G. Hyde; J. R. Shields; H. Stillman.
Celment: M. Kind.
Coton: W. C. Hanna.
Emeryville: D. Finley.
Hermosa Beach: G. Nelson.
Heroult: E. B. Nelson.
Los Angeles: D. B. W. Alexander; L. A. Dubbs; F. W. Huber; R. G. Osborne; A. F. Rosenheim; K. D. Schwendener; P. Weeks.
Marysville: C. A. Trow.
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Pasadena: G. A. Damon.
San Francisco: R. S. Buck; H. A. Campbell; W. A. Doble; H. M. Fitch; E. L. Foucar; W. H. George; Heller and Wilson; L. L. Hohl; L. E. Hunt; R. E. Noble and Company; J. M. O'Hara; W. C. Riddell; A. A. M. Russell; Smith, Emery and Company; F. W. Tibbetts; C. F. Wieland.
Stanford University: Leland Stanford Junior University; C. B. Wing.
West Berkeley: California Corrugated Culvert Company.

COLORADO.

Boulder: M. S. Ketchum; C. C. Williams.
Denver: L. G. Carpenter; J. Y. Jewett; A. Simpson, Jr.
Pueblo: Colorado Fuel and Iron Company; G. L. DeRhodes.

CONNECTICUT.

Ansonia: H. C. Jennison.

Bridgeport: Bridgeport Brass Company; A. P. Ford; G. P. McCarthy, Jr.; M. F. McKenna; E. S. Sperry; R. F. Stoddart; W. R. Webster.

Groton: W. G. Lumsden.

Hartford: W. D. Chase; Hartford Steam Boiler Inspection and Insurance Company; The Johns-Pratt Company; W. T. Sears; H. Souther.

New Britain: W. S. Rowland.

New Haven: C. B. Langstroth; W. H. Moore; Sheffield Scientific School Library; W. K. Shepard; L. S. Storrs; Winchester Repeating Arms Company.

Stamford: A. H. Emery; B. Ogden.

Suffield: R. E. Spaulding.

Waterbury: American Brass Company; Chase Rolling Mill Company; E. O. Goss; H. L. Thompson.

West Haven: E. H. Raquet.

DELAWARE.

Wilmington: H. M. Barksdale; N. H. Davis; Harlan and Hollingsworth Corporation; W. W. Lobdell; C. Warner.

DISTRICT OF COLUMBIA.

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FLORIDA.

Gainesville: W. A. Fisher.

GEORGIA.

Rockmart: J. L. Mack.

Savannah: F. I. Gibson.

IDAHO.

Boise: A. P. Adair.

Moscow: C. N. Little.

Twin Falls: M. M. Murtaugh.

ILLINOIS.

Champaign: J. O. Taylor.

Chicago: American Asphaltum and Rubber Company; American Bureau of Inspection and Tests; American Steel Foundries; J. G. Bergquist; C. W. Boynton; Bradley and Vrooman Company; W. Brady; I. M. Bregowsky; J. Brunner; R. T. Brydon; F. O. Bunnell; H. J. Burt; H. M. Byllesly and Company, Library; J. M. Carmody; W. M. Carpenter; C. H. Cartlidge; Commonwealth-Edison Company; T. L. Condron; W. A. Converse; Crane Company; G. M. Davidson; J. P. Dike; R. W. Evans; A. G. Fay; R. Forsyth; W. Forsyth; R. M. Gerety; S. A. Greeley; H. Green; H. C. Griswold; E. Gudeman; E. M. Hagar; P. B. Harrison; C. D. Hill; L. S. Hughes; R. W. Hunt and Company; H. C. Hutchins; Illinois Central Railroad Company; Illinois Steel Company; S. H. Ingberg; Inland Steel Company; International Harvester Company; Interstate Iron and Steel Company; J. N. Jensen; M. T. Jones; L. Kirschbraun; J. W. Lawrie; A. E. Lindou; C. F. Loweth; J. R. MacGregor; H. Mannhardt; Marquette Cement Manufacturing Company; E. D. Martin; H. M. McCormack; W. Michaelis, Jr.; A. V. H. Mory; A. W. Moseley; National Fireproofing Company; J. F. Nickerson; C. G. Osborne; S. Otis; C. E. Paul; *Railway and Engineering Review;* G. W. Riddle; Roberts and Schaefer Company; A. F. Robinson; *Rock Products;* J. T. Ryerson and Son; E. C. and R. M. Shankland; J. S. Sheafe; J. D. Sinkinson; J. H. Spengler; Standard Asphalt and Rubber Company; Standard Screw Company; W. B. Storey, Jr.; C. L. Strobel; Titanium-Alloy Manufacturing Company; I. Van Trump; F. K. Vial; United States Gypsum Company; J. J. Walledom; M. H. Wickhorst; R. A. Widdicombe; L. I. Yeomans.

DePue: M. F. Chase.

East St. Louis: E. H. Oehler.

Granite City: R. A. Bull; J. W. Mills.

Hawthorne: O. Linder.

Moline: D. H. Stacks.

Monmouth: A. W. Gates.

Oglesby: J. W. Ganser; H. S. Turner.

Rock Island: D. M. King; W. M. Mansfield.

South Chicago: O. Eisenschiml; E. S. Gardner.

Springfield: A. N. Johnson.

Urbana: D. A. Abrams; A. V. Bleininger; W. F. M. Goss; H. F. Moore; S. W. Parr; W. A. Slater; State Geological Survey; A. N. Talbot.

West Chicago: Calamut Steel Company.

Wilimette: G. Magee, Jr.

INDIANA.

East Chicago: C. W. Lytle.

Fort Wayne: G. M. Hofman.

Gary: W. E. Graham; H. C. Thomas; J. B. Thorpe.

INDIANA.—*Continued.*

Indianapolis: W. I. Ballentine; A. S. Bixby; J. R. Francis; E. B. Hall; H. E. Jordan; H. A. Schwartz.

Lafayette: A. E. Berdon; R. G. Dukes; W. K. Hatt; A. P. Poorman; Purdue University Library; H. H. Scofield.

La Porte: M. Rumely Company.

Portland: W. C. Hoover.

South Bend: Studebaker Corporation.

Terre Haute: W. P. Childs; M. A. Howe.

Valparaiso: R. C. Yoeman.

IOWA.

Ames: A. O. Anderson; J. T. Bates; R. W. Crum; H. W. Gray; A. Marston.

Armstrong: P. H. Atwood.

Burlington: F. W. Salmon.

Des Moines: M. L. Patzig; C. A. Rawson.

Estherville: L. L. Bingham.

Iowa City: M. G. Wyer.

Mason City: G. P. Diekmann.

KANSAS.

Coffeyville: H. B. Setzler.

Lawrence: C. I. Corp; H. Gardner; F. O. Marvin; H. A. Rice; University of Kansas, School of Engineering.

Leavenworth: F. E. Washburn.

Manhattan: Kansas State Agricultural College Library.

Mildred: P. W. Marx.

Pittsburg: L. E. Curfman.

Topeka: H. B. MacFarland; W. A. Powers.

KENTUCKY.

Louisville: B. Montfort.

Newport: W. R. Fleming.

LOUISIANA.

New Orleans: G. J. Glover; Tulane University, Department of Experimental Engineering.

MAINE.

Orono: H. S. Boardman.

MARYLAND.

Annapolis: Bureau of Steam Engineering; W. Cole; F. Lyon; M. E. Reed; School of Marine Engineering Library.

Baltimore: Bartlett, Hayward and Company; A. T. Clark; F. H. Clark; O. C. Cromwell; W. W. Crosby; J. A. Davis; W. R. Edwards; J. E. Greiner; E. C. Heald; R. K. Meade; J. R. Onderdonk; Penniman and Browne; E. K. Rothstein; C. P. Van Gundy.

Cumberland: W. L. Sperry.

Sparrows Point: H. C. Lane; S. S. Martin; F. A. Weymouth; F. W. Wood.

MASSACHUSETTS.

Ashburnham: C. A. Hubbell.

Boston: E. G. Bailey; R. E. Bakenhus; F. A. Barbour; P. Barker; E. A. Barrier; C. R. Boggs; Boston Elevated Railway Company; Boston Society of Architects; G. H. Brazer; F. N. Bushnell; H. P. Eddy; W. E. C. Eustis; H. Fay; J. W. Fellows; F. W. Ferguson; C. E. Fuller; A. H. Gill; W. Goodenough; R. K. Hale; H. W. Hayward; J. O. Henshaw; C. J. Hogue; A. F. Holmes; Inspection Department, Associated Factory Mutual Fire Insurance Company; W. A. Johnston; E. N. Lake; E. S. Larned; A. D. Little, Incorporated; Lockwood, Greene and Company; C. L. Norton; J. G. Rote; P. P. Sharples; H. L. Sherman; H. J. Skinner; L. S. Smith; J. P. Snow; H. P. Talbot; Waldo Brothers; W. H. Walker; Warren Brothers Company; L. C. Wason; H. J. Williams; J. R. Worcester.

Brookline: E. S. Lincoln, Incorporated; H. F. Tucker.

Cambridge: H. M. Boylston; E. T. Davis; Harvard College Library; H. J. Hughes; L. J. Johnson; W. F. Kearns; G. H. Perkins; A. Sauveur; G. F. Swain.

Clinton: F. W. Bateman.

Dedham: G. W. Coggeshall.

Easton: W. E. Farrell.

East Walpole: W. E. Sumner.

Everett: R. G. Morse.

Holyoke: R. E. Newcomb.

Jamaica Plains: C. King; E. C. Wallace.

Lee: W. W. Maclay.

Malden: C. P. Price.

Merrimac: Eastern Hard Fibre Company.

New Bedford: T. B. Akin.

Newton Highlands: S. E. Thompson.

North Egremont: E. L. Corthell.

Oak Bluffs: A. T. Derry.

Pittsfield: A. McK. Gifford; A. B. Hendricks, Jr.

Quincey: Fore River Shipbuilding Company.

Southbridge: W. L. Oakden.

Springfield: E. G. Brick; The Emerson Laboratory; K. R. Sternberg.

Tufts College: Tufts College, Department of Engineering.

MASSACHUSETTS.—*Continued.*

West Lynn: General Electric Company, Lynn Works.

Worcester: American Steel and Wire Company; J. W. Bishop Company; F. C. Elder; L. D. Granger; G. S. McFarland; E. H. Peirce; F. W. Roys; J. F. Tinsley; Worcester Polytechnic Institute; The Wyman and Gordon Company.

Wollaston: H. E. K. Ruppel.

MICHIGAN.

Ann Arbor: E. E. Ware; A. H. White.

Birmingham: D. T. Randall.

Detroit: The Aluminum Castings Company; J. W. Barbey; F. F. Beall; Berry Brothers, Limited; C. T. Bragg; The Detroit Testing Laboratory; D. M. Ferguson; General Motors Company; C. H. Jumper; A. W. Munsell; C. S. Neal; R. A. Plumb; W. H. Sellew; K. W. Zimmerschied.

East Lansing: J. A. Polson.

Grand Rapids: T. W. Simpson; H. G. Whitman.

Houghton: J. M. Wagner.

Hubbell: J. B. Cooper; G. L. Heath.

Three Rivers: E. C. Champion.

Sault Ste. Marie: L. C. Sabin.

Union City: A. Lundteigen.

MINNESOTA.

Duluth: E. K. Coe; F. Cremer; C. J. Enger.

Minneapolis: E. H. Brown; W. H. Kavanaugh; O. N. Trooien.

St. Paul: J. T. Stewart; D. Tissing; R. M. Woods.

MISSISSIPPI.

University: A. M. Muckenfuss.

MISSOURI.

Columbia: A. L. Hyde; F. P. Spalding.

Independence: J. L. Mack.

Joplin: J. A. Schaeffer.

Kansas City: W. S. Dickey; E. L. Heidenreich; J. E. Muhlfeld; G. H. Tefft; J. A. L. Waddell.

St. Louis: T. R. Akin; B. F. Bush; Campbell Glass and Paint Company; A. W. Clark; C. W. S. Cobb; O. L. Garrison; N. B. Gregg; Hoyt Metal Company; J. J. Kessler; H. W. Lohmann; Missouri Pacific Railway Company; C. D. Purdon; E. J. Russell; C. E. Smith; City of St. Louis Testing Laboratory; R. M. Strong; E. O. Sweetser; J. Taylor; J. L. Van Ornum; H. von Schrenk; J. T. Wallace.

MONTANA.

Anaconda: Anaconda Copper Mining Company.
Bozeman: Montana College of Agriculture and Mechanic Arts.
Helena: R. O. Hoyt.
Pony: W. W. Strange.

NEBRASKA.

Lincoln: G. R. Chatburn; C. E. Mickey.
Omaha: N. F. Harriman; J. Hoffhine.
South Omaha: W. H. Low.

NEVADA.

Hazen: W. J. Card.
Reno: University of Nevada Library.

NEW HAMPSHIRE.

Claremont: G. C. Warner.
Laconia: H. B. Tilton.

NEW JERSEY.

Alpha: A. F. Gerstell.
Ampere: Crocker-Wheeler Company.
Atlantic City: H. H. Campbell; W. I. Cherry.
Bayonne: J. L. Gray; T. T. Gray; K. G. MacKenzie.
Boonton: R. W. Seabury.
Bound Brook: H. Abraham.
Burlington: W. R. Conard; J. A. Hayes.
Camden: Camden Forge Company; J. L. De Bertodano; E. H. Rigg.
Chrome: L. Addicks.
Elizabeth: S. A. Howell.
Gibbsboro: J. Lucas and Company; D. L. Tchorni.
High Bridge: J. H. Hall; J. M. Sherrerd; K. Taylor; R. J. Young.
Hoboken: T. J. Bateman; F. L. Pryor; T. B. Stillman.
Jersey City: W. J. Corliss; Joseph Dixon Crucible Company; J. A. Munsell; S. P. Thacher; L. W. Walter.
Long Branch: C. E. Nordell.
Mahwah: F. W. Sargent.
Maurer: C. N. Forrest.
Montclair: W. Kent.
Newark: B. L. Chandler; W. N. Hazen; R. E. Jennings, 2nd; The Nairn Linoleum Company; J. Owen; T. P. Payne; M. Schreiber; M. R. Sherrerd; M. N. Shoemaker; A. P. Sloan, Jr.; G. D. White.
Passaic: F. Dannerth; Manhattan Rubber Manufacturing Company.
Perth Amboy: F. L. Antisell; H. W. Fisher; J. C. Rossi; Standard Underground Cable Company.

NEW JERSEY.—*Continued.*

Phillipsburg: W. R. Dunn.
Plainfield: F. Conlin; H. D. Hibbard; C. P. Karr.
Ridgefield Park: C. de Wyrall.
Summit: E. D. Nelson.
Stewartsville: H. E. Kiefer.
Trenton: H. C. Boynton; R. B. Gage; A. C. Gregory; J. A. Roebling's Sons Company.
Upper Montclair: C. A. Mead.
Watchung: American Foundrymen's Association; R. Moldenke.

NEW YORK.

Afton: R. H. Carrington.
Albany: W. R. Davis; L. H. Dumary; R. S. Greenman; F. W. Kelley; J. A. Murray, Jr.; J. E. Myers; E. Touceda; E. J. Wheeler; W. H. Yates.
Amsterdam: J. E. Dore.
Bedford Hills: H. M. Howe.
Brooklyn: C. W. Aiken; W. H. Broadhurst; G. V. Catuna; W. H. Chater; E. J. Fort; A. I. Frye; H. L. Greene; G. T. Hammond; A. Helwig; A. Hinrichs; F. P. Ingalls; G. Kaufman; W. I. Keeler; J. S. Kennedy; J. W. Masury and Son; J. P. Millwood; A. Rogers; H. Le H. Smith; G. W. Thompson; M. L. Voight; W. F. Wells.
Buffalo: W. M. Armstrong; W. M. Corse; A. L. Johnson; Spencer Kellogg and Sons; Lackawanna Steel Company; R. W. Lindsay; Pierce Arrow Motor Car Company; C. W. Sherman.
Crown Point: C. W. Murdock.
Elmira: R. T. Lewis.
Flushing: A. H. Sabin
Glen Cove: F. Price.
Glen Falls: International Paper Company.
Gloversville: G. Orr.
Hastings-upon-Hudson: G. P. Hemstreet.
Hoosick Falls: J. A. Beckett; S. C. Cluett.
Hudson: A. Neu
Ilion: Remington Arms and Ammunition Company.
Ithaca: R. C. Carpenter; I. P. Church; Cornell University Library; E. E. Haskell; H. S. Jacoby; H. Ries.
Jamaica: O. Erlandsen.
Laurel Hill: J. B. Herreshoff, Jr.
Little Falls: G. B. Banks.
Lockport: L. E. Howard.
New Brighton: J. F. Thompson.
Newburgh: E. Penny.
New Lebanon: A. J. Kohlhofer.
New York: H. H. Adams; A. Allen, Jr.; H. B. Allen; American Bridge Company; American Bureau of Shipping; American Electric Railway En-

NEW YORK.—*Continued.*

gineering Association; American Society of Engineering Contractors; American Telephone and Telegraph Company; F. M. Andrews and Company; T. P. Armstrong; W. D. Arter; E. B. Ashby; C. V. Bacon; F. T. H. Bacon; J. F. Bacon; A. A. Baker; Barrett Manufacturing Company; S. H. Bassett; G. Baum; W. N. Beach; B. Berger; A. H. Blanchard; C. P. Bliss; Boller, Hodge and Baird; W. A. Bostwick; A. L. Bowman; O. Brainard; L. F. Braine; F. A. Burdett; W. H. Burr; W. Campbell; A. Carnegie; A. B. Chamberlin; F. P. Cheesman; M. E. Chester; J. A. Church; S. R. Church; A. Churchward; E. A. S. Clarke; E. B. Cobb; T. I. Coe; W. T. Corbett; W. C. Cuntz; D. A. Cutler; J. V. Davies; C. Davis; C. H. Davis; E. W. DeKnight; Detroit Graphite Company; F. W. Devoe and C. T. Raynolds Company; L. C. Dilks; J. Douglass; W. J. Douglass; A. W. Dow; J. S. Doyle; H. B. Drowne; P. H. Dudley; B. W. Dunn; H. Dunning; J. O. Eckersley; O. M. Eidlitz; Electrical Testing Laboratories; A. H. Elliott; *Engineering Record;* S. M. Evans; M. S. Falk; A. Falkenau; F. M. Farmer; H. S. Fleming; J. H. Flynn, Jr.; A. E. Forstall; F. E. Foss; H. Fougner; G. L. Fowler; J. W. Frank; J. B. French; R. H. Gaines; H. P. Gallogly; T. J. Gannon; B. K. Garvin; J. Gayley; F. A. Goetze; E. P. Goodrich; A. R. Gormully; W. S. Gould; J. H. Gregory; A. B. Hager; C. W. Hall; S. Hamburger; C. S. Hamner; W. J. Harvie; W. W. Havens; R. Hering; C. E. Hermann; P. S. Hildreth; H. P. Hill; N. S. Hill, Jr.; H. B. Hodges; O. Hoff; J. L. Holst; A. C. Horn; O. E. Hovey; J. W. Howard; O. Z. Howard; W. C. Huntington; C. T. Hutchinson; *The Iron Age;* R. J. Jenks; R. E. Jennings; I. G. Johnson and Company; S. W. Jones; E. Jonson; H. Josias; J. L. Kemmerer; R. B. Kendig; J. J. Kennedy; W. H. Kershaw; J. A. Kinkead; C. Kirchhoff; P. A. Kirchner; O. H. Klein; J. A. Knighton; G. F. Kunz; H. A. La Chicotte; C. G. E. Larsson; R. H. Laverie; Ledoux and Company; J. H. Lidgerwood, Jr.; P. T. Lindhard; E. McL. Long; *Lloyds' Register of Shipping;* A. N. Lukens; J. S. Macgregor; W. Main; C. P. Marsh; H. McBurney; J. C. McGuire; P. C. McIlhiney; C. F. McKenna; E. D. Meier; C. Meriwether; M. Merriman; *The Metal Industry;* R. P. Miller; J. L. Miner; A. E. Mitchell; L. S. Moisseiff; G. E. Molleson; F. B. Morse; A. Moyer; W. Mueser; C. R. Myer; New Jersey Zinc Company; New York Central and Hudson River Railroad Company, Engineering Department; New York Fire Insurance Exchange; W. C. O'Neill, Jr.; Orford Copper Company; C. J. Osborn; W. F. Parish; D. Pierce; A. Polk; L. R. Pomeroy; H. F. J. Porter; W. H. Powell; A. J. Provost, Jr.; Railway Steel Spring Company; D. H. Ray; Raymond Concrete Pole Company; M. Raymond; T. E. Rhodes; C. Richardson; L. D. Rights; A. E. Roberts; Rome Merchant Iron Mill; W. B. Ruggles; A. H. Sawyer; F. E. Schmitt; H. J. Schnell; F. Schniewind; A. W. Schwartz; H. B. Seaman; Sement-Solvay Company; G. F. Shaffer; A. F. Shore; C. Shults; F. P. Smith; Society of Gas Engineering of New York; H. Spencer; T. G. Sperling; G. C. Stone; B. Stoughton; E. Stuetz; New York Technischer Verein; E. Thacher; M. Toch; C. Tomkins; T. Towne; H. C. Turner; F. F. Vandevort; Viele,

NEW YORK.—*Continued.*

Blackwell and Buck; W. Vredenburgh, Jr.; Waclark Wire Company; J. E. Wadsworth; D. E. Waid; L. Waldo; W. R. Walker; Western Electric Company; Western Union Telegraph Company; Westinghouse, Church, Kerr and Company; F. W. Weston; S. Wetherill; S. Whinery; D. Whipple; G. C. Whipple; J. G. White and Company; H. L. Whittemore; F. C. Wight; W. O. Wiley; F. P. Witmer; J. E. Woodwell; I. H. Woolson; W. W. Young; C. H. Zehnder.

Niagara Falls: F. A. J. Fitz Gerald; A. H. Hooker; International Acheson Graphite Company.

Portchester: H. J. Miller.

Potsdam: T. S. Clarkson Memorial School of Technology.

Prince Bay: The S. S. White Dental Manufacturing Company.

Richmond Hill: W. H. Nuessey; R. C. Strachan.

Rochester: Bausch and Lomb Optical Company; F. R. Baxter.

Schenectady: American Locomotive Company; J. A. Capp; General Electric Company; S. V. Hunnings; Schenectady Varnish Company.

Syracuse: W. H. Blauvelt; J. N. Bourg; W. B. Cogswell; H. H. Franklin Manufacturing Company; J. A. Mathews; J. H. Nead; H. A. Pardee.

Tonawanda: J. G. Joseph.

Troy: M. P. Doran; W. V. T. Fonda; J. C. Hoar; T. R. Lawson; Ludlow Valve Manufacturing Company; Rensselaer Polytechnic Institute; C. T A. Sibbald; J. Z. Street; G. S. Thompson; L. S. Tsang.

Victor: The Locke Insulator Manufacturing Company.

West Albany: R. W. Mahon.

Westport: M. A. Walker.

NORTH CAROLINA.

Canton: L. Buck.

NORTH DAKOTA.

University: University of North Dakota.

OHIO.

Akron: W. C. Geer; The B. F. Goodrich Company; J. J. Starr; J. H. Wagenhorst.

Canton: J. T. Hay; H. G. Kiefer.

Cincinnati: F. W. Cherrington; Cincinnati Chapter, American Institute of Architects; Eagle White Lead Company; G. K. Elliott; Elzner and Anderson; R. Hockstetter; A. L. Jenkins; O. Phillips; L. G. Robinson; J. R. Sanborn; H. Schneider; F. L. Swanberg.

Cleveland: R. R. Abbott; W. F. Abel; H. B. Anderson; A. O. Backert; G. W. Balkwill; W. P. Blair; The Brown Hoisting Machinery Company; Case School of Applied Science, Department of Civil Engineering; R. Cathcart; The Cleveland Engineering Society; B. Crowell; H. F. Deverell;

OHIO.—*Continued.*

E. W. Furst; D. Gaehr; J. H. Herron; Kelley Island Lime and Transportation Company; H. R. Kimmel; H. M. Lane; *The National Petroleum News;* F. H. Neff; J. H. Nelson; The Osborn Engineering Company; F. J. Peck and Company; The Peerless Motor Car Company; The Perfection Spring Company; The Sherwin-Williams Company; H. E. Smith; O. Textor; G. H. Tinker; W. S. Tyler Company; T. D. West.

Collinwood: T. F. Clay, Jr.; G. E. Doke.

Columbus: Burgess and Long; H. M. Bush; D. J. Demorest; W. L. Melick; E. Orton, Jr.; G. P. Robinson.

Dayton: F. O. Clements; E. A. Deeds; A. Giesler; H. G. Kittredge; D. A. Kohr; The Lowe Brothers Company; The National Cash Register Company; H. M. Williams.

Elyria: C. M. Campbell.

Findlay: J. L. Child.

Mansfield: R. H. Arnold.

Middletown: J. A. Aupperle; W. J. Beck; R. B. Carnahan, Jr.; G. H. Charls; S. R. Rectanus.

Sandusky: S. B. Newberry.

Steubenville: E. T. Wood.

Toledo: D. M. Luehrs.

Warren: W. T. Clark.

Youngstown: H. B. McMaster; G. W. Peffer; C. S. Robinson; J. P. Young; Youngstown Sheet and Tube Company.

OKLAHOMA.

Dewey: F. L. Woods.

Stillwater: J. L. Jones.

OREGON.

Corvallis: S. H. Graf.

Portland: D. D. Clarke; R. S. Edwards; E. W. Lazell; J. K. Moore; W. R. Phillips; Portland Gas and Coke Company.

PENNSYLVANIA.

Alequippa: S. G. Stafford.

Allentown: Allentown Portland Cement Company; B. Enright; E. B. McCready; H. A. Reninger; D. E. Ritter.

Altoona: W. O. Dunbar; W. F. Kiesel, Jr.; G. B. Koch; P. Kreuzpointner; H. K. McCauley; M. E. McDonnell; F. N. Pease; S. C. Potts; H. M. Ramsay; H. B. Rodman; A. S. Vogt; J. T. Wallis; C. D. Young.

Ambridge: J. J. Boyle; G. F. Sparhawk.

Apollo: R. Lock.

Beaver Falls: W. W. Burritt; H. H. Robertson; Union Drawn Steel Company.

Bethlehem: G. S. Chiles; J. E. Leibfried.

PENNSYLVANIA.—*Continued.*

Brackenridge: V. Browne.
Braddock: G. D. Chamberlain.
Bridgeville: B. Saklatwalla.
Bryn Mawr: T. N. Ely.
Burnham: O. C. Skinner; Standard Steel Works Company; D. Thomas; H. F. Walker.
Butler: G. I. King.
Canonsburg: G. C. Schade.
Carbondale: A. P. Trautwein.
Catasauqua: J. W. Fuller, Jr.; L. Peckitt; H. J. Seaman; R. W. G. Wint.
Chester: A. M. Comey; W. M. Page; Penn Steel Castings and Machine Company; W. Tassin.
Clearfield: Clearfield Clay Working Company.
Coatesville: Lukens Iron and Steel Company; H. Taggart; Worth Brothers Company.
Conshohocken: W. A. Cooper; A. Wood, 3d.
Creighton: C. H. Kerr.
Crum Lynn: J. I. Rogers.
Du Bois: Buffalo, Rochester and Pittsburg Railway Company.
Duquesne: J. S. Unger.
Easton: B. F. Fackenthal, Jr.; F. Firmstone; Lafayette College Library; J. M. Porter; P. W. Shimer.
East Pittsburgh: C. B. Auel; W. A. Bole; T. D. Lynch; C. E. Skinner.
Eddystone: W. A. Cromwell.
Emporium: A. C. Blum.
Erie: H. E. Diller; A. Jarecki.
Franklin: P. H. Conradson; Frankln Steel Company.
Glenshaw: F. L. Garlinghouse.
Greensburg: J. P. Donohoe; W. F. Elwood.
Harrisburg: D. G. Anderson; Central Iron and Steel Company; A. S. McCreath and Son; Pennsylvania State Highway Department.
Hollidaysburg: J. K. McLanahan, Jr.
Homestead: J. H. Grose.
Irwin: E. F. Wilson.
Johnstown: Cambria Steel Company; E. F. Kenney; R H. Noderer; R. E. Penrod.
Kittanning: W. Gowie.
Latrobe: C. E. Corson; E. T. Edwards.
Lebanon: American Iron and Steel Manufacturing Company; C. J. Gadd.
Marcus Hook: J. H. Pew.
Masontown: H. E. Elson.
McKeesport: D. M. Buck; G. M. Goodspeed; J. M Jeffers; J. A. McCulloch.

PENNSYLVANIA.—*Continued.*

Monesson: J. H. Watt.
Munhall: J. M. Camp; J. A. Henry; G. A. Hopkins; J. W. McGrady.
Nazareth: J. Brobston.
New Castle: United States Sherardizing Company.
Norristown: A. H. Fox.
Oakmont: J. L. Jones.
Packerton: Lehigh Valley Railroad Company.
Palmerton: G. Rigg.
Parkesburg: H. A. Beale, Jr.; G. Thomas, 3d; H. B. Wiese.
Pencoyd: A. P. Hume; C. Major; M. E. Rupp.
Philadelphia: H. C. Adams; G. Aertsen; W. A. Aiken; Ajax Metal Company; Aluminate Patents Company; R. I. D. Ashbridge; Baldwin Locomotive Works; Barber Asphalt Paving Company; W. L. Batt; H. C. Berry; J. Birkinbine; A. Bonzano; Booth, Garrett and Blair; S. B. Bowen; H. DeH. Bright; J. G. Brown; R. P. Brown; W. C. Bullitt; A. M. Burnap; G. Butler; A. J. Christie; E. Clark; J. A. Colby; B. T. Conwell, Jr.; The Wm. Cramp and Sons Ship and Engine Building Company; J. M. Cratty; H. C. Crawford; J. Dallas; G. C. Davies; Dodge, Day and Zimmerman; W. H. Doering; W. C. DuComb, Jr.; M. W. Easby; L. T. Emory; J. T. Fennell; L. R. Ferguson; R. H. Fernald; T. Fisher; S. G. Flagg, Jr.; P. W. Frankfurter; Franklin Institute; W. H. Fulweiler; A. W. Gibbs; Glasgow Iron Company; F. J. Glueck; E. T. Greene; R. E. Griffith; H. L. Haldeman; W. H. Harding; H. J. Hartley; W. G. Hartranft Cement Company; H. E. Hayward; W. W. Hearne; F. C. Heath; G. B. Heckel; H. Hess; M. E. Hibbs; R. W. Hilles; Hughes and Patterson; R. L. Humphrey; R. K. Johnson; J. R. Jones; F. G. Kennedy, Jr.; L. H. Kenney; W. C. Kent; F. A. Lane; G. Lanza; R. W. Lesley; J. B. Lober; A. Lovell; E Marburg; Midvale Steel Company; J. B. Miles; C. M. Mills; D. A. Morris; T. Olsen; T. Y. Olsen; A. E. Outerbridge, Jr.; Pennsylvania Crusher Company; A. B. Perley; R. S. Perry; G. Peterson; G. H. Pickard; M. M. Price; H. H. Quimby; W. B. Reinke; J. T. Richards; W. B. Riegner; F. A. Richlé; C. D. Rinald; S. P. Sadtler and Son; C. C. Schneider; J. C. Sellers, Jr.; W. Sellers and Company, Incorporated; E. B. Smith; A. Sommer; H. S. Spackman Engineering Company; C. R. Spare; C. E. Stafford; A. A. Stevenson; C. M. Taylor; W. P. Taylor; J. C. Trautwine, Jr.; W. J. Tretch; United Gas Improvement Company; United States Cast Iron Pipe and Foundry Company; J. L. Vauclain; S. T. Wagner; C. L. Warwick; G. S. Webster; W. R. Webster; D. B. Wentz; C. T. Wetherill; H. V. Wille; P. H. Wilson; O. C. Wolf; E. R. Wood, Jr.; F. B. Wood; R. D. Wood and Company; W. Wood; G. H. Woodroffe.
Phœnixville: J. S. Deans; N. R. McLure.
Pittsburgh: I. C. Allen; American Waterworks and Guarantee Company; C. E. Augustine; C. G. Bacon, Jr.; H. C. Barnes; P. H. Bates; A. W. Belden; L. H. Bowman; A. M. Brown; Brown and Company, Incorporated; Carbon Steel Company; The Carnegie Institute; Carnegie Library;

PENNSYLVANIA.—*Continued.*

Carnegie Steel Company; Carter Iron Company; Columbia Steel and Shafting Company; E. A. Condit, Jr.; D. F. Crawford; A. E. Crockett; R. A. Cummings; W. C. Cushing; J. Dewar; B. Dewey; J. W. Dougherty; J. A. Dubbs; W. E. Emley; Engineers' Society of Western Pennsylvania; M. S. Evans; S. B. Flagg; Follansbee Brothers Company; E. D. Frohman; H. F. Gilg; J. M. Gillespie; G. W. Greene; H. Gulick, Jr.; J. L. Haines; C. Hall; C. L. Hastings; C. W. Heppinstall; T. E. Hewitt; Heyl and Patterson, Incorporated; S. P. Howell; E. T. Ickes; W. G. Ireland; H. F. Jefferson; C. W. Johnson; Jones and Laughlin Steel Company; J. H. Jones; J. J. Kaylor; W. M. Kinney; E. S. Kniseley; J. O. Leech; T. Lynch; F. M. Masters; J. B. Masters; G. Matheson, Jr.; E. H. McClelland; A. M. McCrea; J. McLeod; D. W. McNaugher; D. H. Murphy; National Tube Company; G. L. Norris; J. E. Ober; J. N. Ostrom; A. Pinkerton; Pittsburg Forge and Iron Company; Pittsburg Testing Laboratory; A. F. Plock; B. H. Rader; W. H. Rieger; R. E. Rogers; S. M. Rodgers; F. Rose; C. F. W. Rys; G. W. Sargent; G. W. Schluederberg; C. Shannon; J. J. Shuman; C. V. Slocum; F. S. Slocum; J. H. Smith; B. E. D. Stafford; F. M. Stapleton; R. S. Suydam; E. Swensson; G. H. Taber; H. P. Tiemann; N. B. Trist; J. L. Uhler; Union Steel Casting Company; H. E. Walters; I. Weil; West Penn Traction Company; Westinghouse Electric and Manufacturing Company; C. D. Wettach; H. M. Wilson; R. B. Woodworth; J. F. Wulfetunge.

Pittston: J. K. Griffith.

Pottstown: E. S. Cook.

Pottsville: A. G. Blakeley.

Rankin: P. L. Wolfel.

Reading: The Carpenter Steel Company; L. J. Heizmann; Reading Iron Company; The A. Wilhelm Company; J. B. Young.

Ridgway: H. B. Norton.

St. Marys: F. Oberkirch.

Scranton: H. J. Force; J. M. Maris.

Sharon: W. G. Kranz; B. H. Pease; Sharon Steel Hoop Company.

South Bethlehem: Bethlehem Steel Company; R. M. Bird; A. L. Colby; H. S. Drinker; F. P. McKibben; J. W. Richards; F. E. Schall.

State College: P. B. Breneman; Carnegie Library, Pennsylvania State College.

Steelton: H. B. Bent; F. D. Carney; L. B. Lindemuth; The Pennsylvania Steel Company; J. V. W. Reynders.

Titusville: J. T. Dillon, Jr.

Vandegrift: A. H. Beale; H. L. Bodwell; R. G. Scott, Jr.; G. A. White

Washington: S. A. Grayson; F. M. Sanger, Jr.

West Pittsburg: N. W. Buch.

Wilkesbarre: Sheldon Axle Company.

Wilkinsburg: H. J. Lincoln.

Wilmerding: Westinghouse Air Brake Company.

York: C. H. Ehrenfeld.

RHODE ISLAND.

Phenix: F. J. Hoxie.

Providence: Brown and Sharpe Manufacturing Company; Brown University, Department of Mechanical Engineering; J. R. Freeman; A. J. Loepsinger; W. M. Saunders; United States Gutta Percha Paint Company.

TENNESSEE.

Erwin: V. V. Kelsey.
Knoxville: J. A. Switzer.
Lenoir City: G. S. Evans.
Nashville: W. H. Schuerman.
Richard City: W. H. Klein.

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Eagle Ford: M. M. Ludlow.
Dallas: F. L. Sperry.
Fort Worth: F. B. Porter.
El Paso: W. E. Mix.

UTAH.

Salt Lake City: E. H. Beckstrand; O. C. Hart; H. M. Jones.

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Alexandria: J. C. Ramage.
Bedford City: E. D. Gregory.
Blacksburg: W. E. Barlow; J. S. A. Johnson; L. S. Randolph.
Fordwick: L. G. Sprague.
Fredericksburg: G. B. Strickler.
Newport News: Newport News Shipbuilding and Dry Dock Company.
Norfolk: R. Bolling; Castner, Curran and Bullitt, Incorporated; A. S. Flowers; C. B. Shaffer.
Richmond: Foehling and Robertson; F. W. Scarborough; T. S. Wheelwright.
Riverton: National Lime Manufacturing Association.
Roanoke: C. S. Churchill; J. H. Gibboney; A. W. Lewis; L. C. Stewart; C. C. Wentworth.

WASHINGTON.

Concrete: C. L. Wagner.
Seattle: Denny-Renton Clay and Coal Company; Falkenburg and Laucks; A. H. Fuller; O. P. M. Goss; G. E. Hermann; C. A. Newhall; Seattle Construction and Dry Dock Company; R. H. Thomson.
Tacoma: F. T. Crowe and Company; E. O. Heinrich.

WEST VIRGINIA.

Ansted: W. N. Page.
Blue Field: R. Lybrook.
Fairmont: F. R. Haas.
Morgantown: R. P. Davis; C. R. Jones; West Virginia University Library.
Wheeling: A. L. Bell; F. A. Browne; S. L. Davis.

WISCONSIN.

Ashland: Lake Superior Iron and Chemical Company.
Madison: J. Aston; C. F. Burgess; McG. Cline; J. B. Kommers; E. R. Maurer; H. E. McKenzie; F. E. Turneaure; University of Wisconsin Library; M. O. Withey.
Milwaukee: H. S. Falk; F. E. Layman; F. S. Low; R. S. MacPherran; Milwaukee Electric Railway and Light Company; L. Patton; G. N. Prentiss; W. J. Sando; P. J. Weber.
Racine: O. C. Friend.

WYOMING.

Laramie: J. C. Fitterer.

AUSTRALIA.

Melbourne: H. Payne.
Sydney: A. Scheidel.

CANADA.

Calgary: W. H. Kewish.
Dunnville: W. F. Scott.
Grand Mere: L. C. Boyd.
Halifax: F. H. Sexton.
Hamilton: J. G. Morrow.
Montreal: W. F. Angus; I. E. Blumgardt; E. Brown; J. A. DeCew; Dominion Bridge Company; The Duckworth-Boyer Engineering and Inspection Company, Limited; L. N. Edwards; W. H. Ford; G. Giroux; T. S. Griffiths; M. L. Hersey; Imperial Wire and Cable Company, Limited; R. Job; H. O. Keay; H. M. Mackay; S. D. MacNab; McGill University Library; A. Stansfield; M. A. Zuercher.
Orangeville: S. Smith.
Ottawa: G. E. Perley.
Port Colbone: S. R. Preston.
Shawinigan Falls: W. A. Higgins.
Sydney: J. P. McNaughton; A. P. Scott.
Tod Inlet: H. L. Knappenberger.

CANADA.—*Continued.*

Toronto: The Canadian Fairbanks-Morse Company, Limited; Dunlop Tire and Rubber Goods Company; J. Galbraith; The Gutta Percha and Rubber Manufacturing Company; R. W. Hunt Company, Limited; Smith, Kerry and Chace; R. H. Verity.

Vancouver: C. F. Boyce; W. W. Ewing; J. R. Grant; J. V. Nimmo.

Victoria: H. A. Ross.

Welland: F. A. Burger.

Westmount: E. B. Tilt.

Winnipeg: H. B. Lake.

CANAL ZONE (PANAMA).

Corozal: S. B. Williamson.

Cristobal: C. R. Chisholm.

Culebra: H. Goldmark; S. H. Granten; E. E. Lee; T. E. L. Lipscy; A. L. Robinson.; E. Schildhauer.

Gatun: C. P. Fortney; C. Harding; W. H. Storm; G. M. Wells.

Gorgona: Q. A. Hall; B. D. Pender.

CUBA.

Havana: P. D. Buzzi; W. O'Malley.

ENGLAND.

London: L. H. Fry; R. Hawxhurst, Jr.; Patent Office Library; *The Railway Gazette;* L. S. Robertson; M. Ruthenburg; R. H. H. Stanger.

Sheffield: R. A. Hadfield.

Stoke-on-Trent: The English Ceramic Society.

Tredegar: A. O. Whitehead.

FRANCE.

Paris: A. S. Garfield; *Revue de Metallurgie.*

GERMANY.

Düsseldorf: E. Schrodter.

Essen: F. Krupp Company.

Grand Duche de Luxembourg: L. Laval.

GUATEMALA.

Guatemala City: C. F. Novella.

HAWAIIAN ISLANDS.

Honolulu: F. G. W. Cooper; A. R. Keller; J. M. Young.

JAPAN.

Tokio: J. Yamaguchi.

MEXICO.

Chihuahua: W. B. Fuller.
Hidalgo: Cementos Hidalgo, S. A.
Torreon: V. Trevino.

PHILIPPINE ISLANDS.

Manila: Bureau of Science, Library.

PORTO RICO.

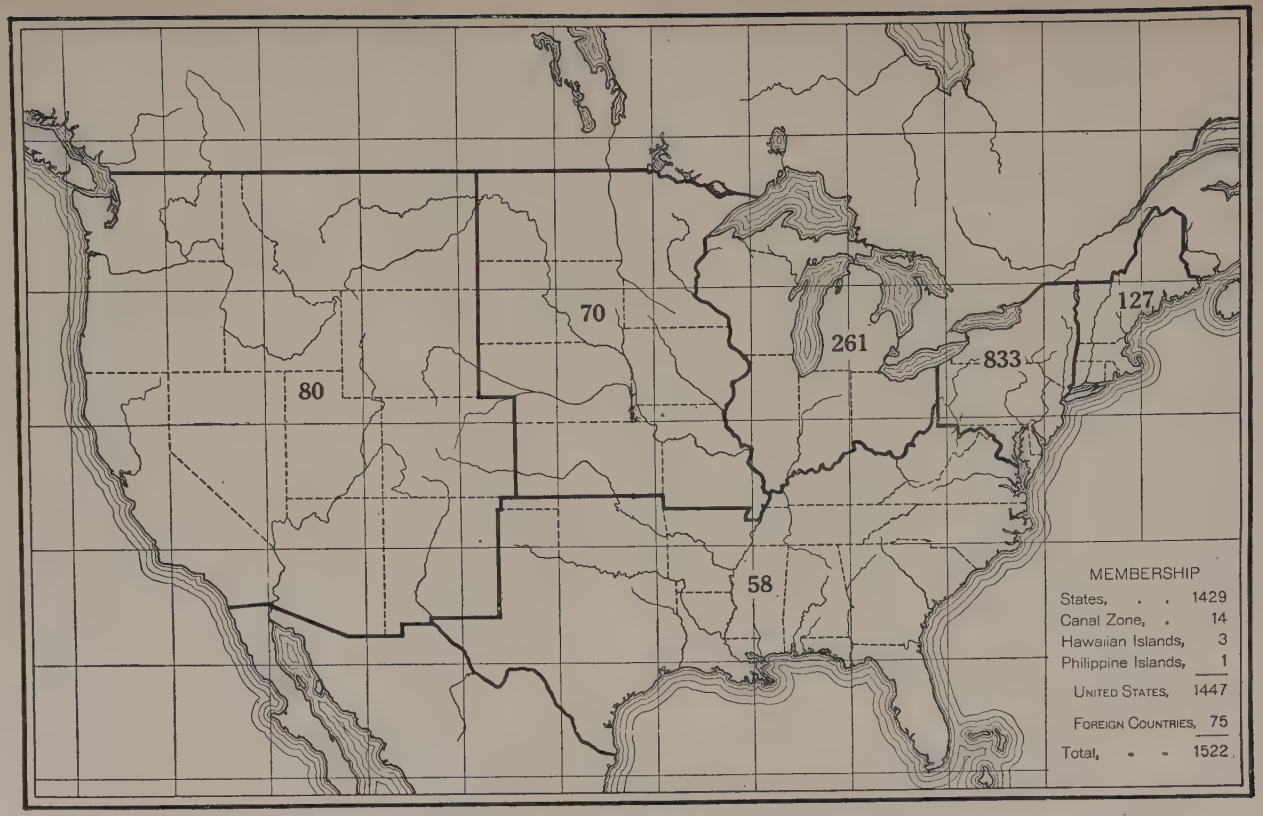
Manati: F. Caso.
San Juan: I. A. Canals.

SOUTH AFRICA.

Johannesburg: Consolidated Goldfields of South Africa, Limited; Consolidated Goldfields of South Africa, Limited—Intelligence Department.

SPAIN.

Madrid: Laboratorio Central para el Ensayo de Materiales.



Map showing the Geographical Distribution of the Membership of the American Society for Testing Materials.

SUMMARY OF GEOGRAPHICAL DISTRIBUTION.

Alabama	9	Minnesota	9	Washington	11
Arizona	1	Mississippi	1	West Virginia	9
California	41	Missouri	30	Wisconsin	20
Colorado	7	Montana	4	Wyoming	1
Connecticut	29	Nebraska	5		
Delaware	5	Nevada	2	Australia	2
Dist. of Columbia	37	New Hampshire	2	Canada	46
Florida	1	New Jersey	65	Canal Zone	14
Georgia	2	New York	324	Cuba	2
Idaho	3	North Carolina	1	England	10
Illinois	108	North Dakota	1	France	2
Indiana	23	Ohio	84	Germany	3
Iowa	12	Oklahoma	2	Guatemala	1
Kansas	12	Oregon	7	Hawaiian Is.	3
Kentucky	2	Pennsylvania	377	Japan	1
Louisiana	2	Rhode Island	7	Mexico	3
Maine	1	Tennessee	5	Philippine Is.	1
Maryland	24	Texas	4	Porto Rico	2
Massachusetts	89	Utah	3	South Africa	2
Michigan	26	Virginia	21	Spain	1

Membership in United States	1,429
Membership in Foreign Countries	93
Total Membership	1,522

PAST OFFICERS.

The Society, from its organization in 1898 till its incorporation under its present name in 1902, was designated the American Section of the International Association for Testing Materials. The officers and members of the Executive Committee during this four-year period were as follows:

Chairmen:

MANSFIELD MERRIMAN, 1898–1900. HENRY M. HOWE, 1900–1902.

Vice-Chairmen:

HENRY M. HOWE, 1898–1900. CHARLES B. DUDLEY, 1900–1902.

Secretaries:

RICHARD L. HUMPHREY, 1898–1900. J. M. PORTER, 1900–1902.

Treasurers:

PAUL KREUZPOINTNER, 1898–1900. ROBERT W. LESLEY, 1900–1902.

Members of Executive Committee:

GUS. C. HENNING, 1898–1900. ALBERT LADD COLBY, 1900–1902.
MANSFIELD MERRIMAN, 1900–1902.

The past officers and members of the Executive Committee of the American Society for Testing Materials since its incorporation under that name in 1902, are as follows:

Presidents:

CHARLES B. DUDLEY, 1902–1909.
HENRY M. HOWE, 1910–1912.

Vice-President:

ROBERT W. LESLEY, 1902–1912.

Members of Executive Committee:

JAMES CHRISTIE, 1902–1911. JOHN MCLEOD, 1902–1907.
ALBERT LADD COLBY, 1902–1905. WILLIAM R. WEBSTER, 1907–1912.

STANDING ADVISORY COMMITTEES.

On Iron and Steel.

William R. Webster, *Chairman.*

C. Kirchhoff, H. V. Wille.

On Cast Iron.

Henry Souther, *Chairman.*

Richard Moldenke, Thomas D. West.

On Cement and Concrete.

Clifford Richardson, *Chairman.*

Richard L. Humphrey, Spencer B. Newberry.

On Brick and Terra-cotta Products.

Edward Orton, Jr., *Chairman.*

H. O. Hofman, W. D. Richardson.

On Preservative Coatings.

G. W. Thompson, *Chairman.*

Robert Job, S. S. Voorhees.

On Tests and Testing Apparatus.

Gaetano Lanza, *Chairman.*

Mansfield Merriman, Tinius Olsen.

TECHNICAL COMMITTEES

OF THE

AMERICAN SOCIETY FOR TESTING MATERIALS.

A. ON FERROUS METALS.

COMMITTEE A-1, ON STANDARD SPECIFICATIONS FOR STEEL.

WILLIAM R. WEBSTER, *Chairman.*
A. A. STEVENSON, *Vice-Chairman.*
EDGAR MARBURG, *Secretary.*

NON-PRODUCERS (56).

Abbott, R. R.
American Bureau of Shipping,
E. P. Stratton.
American Electric Railway Engineering Association.
American Locomotive Company,
F. J. Cole.
S. V. Hunnings.
Baldwin Locomotive Works,
G. R. Henderson.
H. V. Wille.
Beall, F. F.
Bureau of Construction and Repair, U. S. N.,
Design Branch.
Material Branch.
Bureau of Steam Engineering, U. S. N.,
Inspection Division.
Cartlidge, C. H.
Churchill, Charles S.
Clark, F. H.
Colby, Albert Ladd.
Colby, J. Allen.
Committee C-2 on Reinforced Concrete,
R. L. Humphrey.
H. H. Quimby.
S. T. Wagner.
Cramp and Sons Ship and Engine Building Company, William,
W. A. Dodson.
Deans, John Sterling.
Dudley, P. H.
Force, H. J.
Fore River Shipbuilding Company,
H. H. Schulze.
Franklin Manufacturing Company, H. H.,
A. Holmes.
General Electric Company,
J. A. Capp.
General Motors Company,
K. W. Zimmerschied.
Gormully, A. R.
Greiner, J. E.
Hartford Steam Boiler Inspection and Insurance Company,
F. B. Allen.
Hodge, H. W.
Hunt and Company, Robert W.
Koch, George B.
Lanza, Gaetano.
Laverie, R. H.
Lloyds' Register of Shipping,
J. H. Mancor.
Lumsden, W. G.
Mahon, R. W.

COMMITTEE A-1.—*Continued.*

NON-PRODUCERS.—(*Continued.*)

Marburg, Edgar (*Secretary*).
Meier, E. D.
Nelson, E. D.
Newport News Shipbuilding and Dry Dock Company,
E. S. Alexander.
Onderdonk, J. R.
Osborn Engineering Company,
F. C. Osborn.
Pierce-Arrow Motor Car Company,
D. Fergusson.
Pomeroy, L. R.
Richards, Joseph T.
Rigg, E. H.
Schneider, C. C.
Seattle Dry Dock and Construction Company,
J. V. Paterson.
Snow, J. P.
Souther, Henry.
Steamboat Inspection Service (Department of Commerce and Labor),
George Uhler.
Waddell, J. A. L.
Wagner, S. T.
Wallis, J. T.
Webster, William R. (*Chairman*).
Westinghouse Electric and Manufacturing Company,
T. D. Lynch.
Wickhorst, M. H.
Wyman and Gordon Company, The,
G. S. MacFarland.
Young, C. D.

PRODUCERS (31).

American Steel and Wire Company,
F. H. Daniels.
American Steel Foundries,
J. C. Davis.
Bacon, C. G., Jr.
Bethlehem Steel Company,
E. O'C. Acker.
Cambria Steel Company,
E. F. Kenney.
Carnegie Steel Company,
J. O. Leech.
C. F. W. Rys.
H. P. Lemann.
Carpenter Steel Company,
J. H. Parker.
Central Iron and Steel Company,
R. H. Irons.
Colorado Fuel and Iron Company,
J. B. McKennan.
Davis, J. A.
Illinois Steel Company,
P. E. Carhart.
Jones and Laughlin Steel Company,
Jesse J. Shuman.
Lackawanna Steel Company,
F. E. Abbott.
Lukens Iron and Steel Company,
Charles L. Huston.
Martin, S. S.
Mathews, John A.
Midvale Steel Company,
Radclyffe Furness.
National Tube Company,
Frank N. Speller.
Norris, George L.
Penn Steel Castings and Machine Company,
Walter S. Bickley.
Pennsylvania Steel Company,
J. V. W. Reynders.
Rail Steel Bar Manufacturers Association,
L. W. Barnette.
A. S. Hook.
W. H. Woodcock.
Railway Steel Spring Company,
A. S. Henry.
A. N. Lukens.
Reading Iron Company,
George Schuhman.
Rodgers, S. M.
Roebling's Sons Company, J. A.,
H. J. Horne.
Sargent, George W.
Slocum, F. S.
Standard Steel Works Company,
A. A. Stevenson (*Vice-Chairman*).
Wood and Company, R. D.,
Walter Wood.
Worth Brothers Company,
J. L. Hughes.

COMMITTEE A-1.—*Continued.*

SUB-COMMITTEES OF COMMITTEE A-1.

SUB-COMMITTEE I, ON BESSEMER STEEL RAILS, OPEN-HEARTH STEEL RAILS, STEEL GIRDER RAILS AND STEEL SPLICE BARS.

Kenney, E. F. (*Chairman*).
American Electric Railway Engineering Association.
Carnegie Steel Company.
Churchill, C. S.
Colby, A. L.
Illinois Steel Company.
Lackawanna Steel Company.
Martin, S. S.
National Tube Company.
Richards, J. T.
Snow, J. P.
Wickhorst, M. H.

SUB-COMMITTEE II, ON STRUCTURAL STEEL FOR BRIDGES AND BUILDINGS.

Hodge, H. W. (*Chairman*).
Bureau of Construction and Repair, U. S. N.
Cambria Steel Company.
Carnegie Steel Company.
Cartlidge, C. H.
Deans, J. S.
Greiner, J. E.
Lackawanna Steel Company.
Osborn Engineering Company.
Snow, J. P.
Standard Steel Works Company.
Wagner, S. T.

SUB-COMMITTEE III, ON STRUCTURAL STEEL FOR SHIPS.

Bureau of Construction and Repair, U. S. N.
R. H. H. Robinson (*Chairman*).
American Bureau of Shipping.
Cambria Steel Company.
Carnegie Steel Company.
Central Iron and Steel Company.
Cramp and Sons Ship and Engine Building Company, William.
Davis, J. A.
Fore River Shipbuilding Company,
Laverie, R. H.
Lloyds' Register of Shipping.
Lumsden, W. G.
Newport News Shipbuilding and Dry Dock Company,
Pennsylvania. Steel Company.
Rigg, E. H.
Seattle Dry Dock and Construction Company.
Steamboat Inspection Service.
Worth Brothers Company.

SUB-COMMITTEE IV, ON SPRING STEEL.

Souther, Henry (*Chairman*).
Carpenter Steel Company.
General Motors Company.
Koch, George B.
Mahon, R. W.
Midvale Steel Company.
Railway Steel Spring Company.

COMMITTEE A-1.—*Continued.*

SUB-COMMITTEE V, ON STEEL REINFORCING BARS.

Rys, C. F. W. (*Chairman*).
Cambria Steel Company.
Colby, A. L.
Colby, J. A.
Committee C-2 on Reinforced Concrete.
Hunt and Company, R. W.
Jones and Laughlin Steel Company.
Rail Steel Bar Manufacturers Association.

SUB-COMMITTEE VI, ON STEEL AXLES.

Nelson, E. D. (*Chairman*).
American Electric Railway Engineering Association.
Cambria Steel Company.
Carnegie Steel Company.
Colby, A. L.
Jones and Laughlin Steel Company.
Midvale Steel Company.
Standard Steel Works Company.
Young, C. D.

SUB-COMMITTEE VII, ON ROLLED STEEL WHEELS AND STEEL TIRES.

Stevenson, A. A. (*Chairman*).
American Electric Railway Engineering Association.
Bacon, C. G., Jr.
Carnegie Steel Company.
Churchill, C. S.
Mahon, R. W.
Midvale Steel Company.
Nelson, E. D.
Railway Steel Spring Company.
Wickhorst, M. H.
Young, C. D.

SUB-COMMITTEE VIII, ON STEEL FORGINGS.

Acker, E. O'C. (*Chairman*).
Bureau of Construction and Repair, U. S. N.
Carnegie Steel Company.
Colby, A. L.
General Electric Company.
Midvale Steel Company.
Pennsylvania Steel Company.
Westinghouse Electric and Manufacturing Company.

SUB-COMMITTEE IX, ON STEEL CASTINGS.

Carney, F. D. (*Chairman*).
American Steel Foundries.
Colby, A. L.
Bureau of Construction and Repair, U. S. N.
General Electric Company.
Penn Steel Castings Company.
Westinghouse Electric and Manufacturing Company.

SUB-COMMITTEE X, ON STEEL TUBING.

Henderson, G. R. (*Chairman*).
American Locomotive Company.
National Tube Company.
Pennsylvania Steel Company.
Wallis, J. T.

SUB-COMMITTEE XI, ON AUTOMOBILE STEELS.

Colby, A. L. (*Chairman*).
Abbott, R. R.
American Locomotive Company.
Beall, F. F.
Bethlehem Steel Company.
Cambria Steel Company.

COMMITTEE A-1.—*Continued.*

SUB-COMMITTEE XI.—(*Continued.*)

Carnegie Steel Company.
Carpenter Steel Company.
Franklin Manufacturing Company, H. H.
General Motors Company.
Gormully, A. R.
Mathews, J. A.
Midvale Steel Company.
Morris, G. L.
Pennsylvania Steel Company.
Pierce-Arrow Motor Car Company.
Rodgers, S. M.
Sargent, G. W.
Souther, Henry.
Wyman and Gordon Company.

SUB-COMMITTEE XII, ON LOCOMOTIVE MATERIALS.

Cole, F. J. (*Chairman*).
Baldwin Locomotive Works.
Bethlehem Steel Company.
Carnegie Steel Company.
Clark, F. H.
Hartford Steam Boiler Inspection and Insurance Company.
Lukens Iron and Steel Company.
Meier, E. D.
Pennsylvania Steel Company.
Wickhorst, M. H.

SUB-COMMITTEE XIII, ON STEEL FORGING BLOOMS, BILLETS AND SLABS.

Young, C. D. (*Chairman*).
American Locomotive Company.
Cambria Steel Company.
Carnegie Steel Company.
Force, H. J.
Onderdonk, J. R.
Pennsylvania Steel Company.

SUB-COMMITTEE XIV, ON STANDARD METHODS OF CHEMICAL ANALYSIS.

Gibboney, J. H. (*Chairman*).
Cambria Steel Company.
Carnegie Steel Company.
American Locomotive Company.
McDonnell, M. E.
Van Gundy, C. P.

COMMITTEE A-2, ON STANDARD SPECIFICATIONS FOR WROUGHT IRON.

S. V. HUNNINGS, *Chairman.*
J. B. YOUNG, *Secretary.*

NON-PRODUCERS (14).

American Electric Railway Engineering Association.
American Locomotive Company, S. V. Hunnings (*Chairman*).
Baldwin Locomotive Works, H. V. Wille.
Bureau of Construction and Repair, U. S. N.,
Design Branch.
Material Branch.
Bureau of Steam Engineering, U. S. N.,
Inspection Division.
Colby, J. A.
Clark, F. H.
Gannon, Thomas J.
Harriman, N. F.
Hartford Steam Boiler Inspection and Insurance Company, F. B. Allen.
Ramage, J. C.
Snow, J. P.
Young, C. D.
Young, J. B. (*Secretary*).

COMMITTEE A-2.—*Continued.*

PRODUCERS (15).

American Iron and Steel Manufacturing Company, J. P. Brock.
Beale, H. A., Jr.
Brown and Company, Incorporated, James Neale.
Carter Iron Company, R. A. Carter.
Gillespie, J. M.
Glasgow Iron Company, J. P. Roe.
Mahon, R. W.
Molleson, G. E.
Pittsburgh Forge and Iron Company, F. E. Richardson.
Reading Iron Company, George Schuhman.
Rome Merchant Iron Mill, Watson Jenkins, Jr.
Smith, H. E.
Stafford, B. E. D.
Wheelwright, Thomas S.
Worth Brothers Company, C. Shults.

SUB-COMMITTEES OF COMMITTEE A-2.

SUB-COMMITTEE I, ON TUBES AND PIPE.

Woodroffe, G. H. (*Chairman*).
Beale, H. A.
Bureau of Construction and Repair, U. S. N.
Clark, F. H.
Gannon, Thomas J.
Hartford Steam Boiler Inspection and Insurance Company.
Mahon, R. W.
Molleson, G. E.
Reading Iron Company.
Worth Brothers Company.

SUB-COMMITTEE II, ON MERCHANT BAR IRON.

Young, J. B. (*Chairman*).
American Electric Railway Engineering Association.
American Iron and Steel Company.
Baldwin Locomotive Works.
Bureau of Steam Engineering, U. S. N.
Gillespie, J. M.
Pittsburgh Forge and Iron Company.
Ramage, J. C.
Reading Iron Company.
Snow, J. P.

SUB-COMMITTEE III, ON STAYBOLT, ENGINE-BOLT AND CHAIN IRON.

Hunnings, S. V. (*Chairman*).
American Electric Railway Engineering Association.
Brown and Company, Incorporated.
Bureau of Steam Engineering, U. S. N.
Carter Iron Company.
Gillespie, J. M.
Harriman, N. F.
Hartford Steam Boiler Inspection and Insurance Company.
Rome Merchant Iron Mill.
Stafford, B. E. D.
Smith, H. E.
Wheelwright, Thomas S.
Young, C. D.

SUB-COMMITTEE IV, ON PLATES AND SHAPES.

Colby, J. A. (*Chairman*).
Bureau of Construction and Repair, U. S. N.
Gannon, Thomas J.
Gillespie, J. M.
Glasgow Iron Company.
Reading Iron Company.
Snow, J. P.

COMMITTEE A-3, ON STANDARD SPECIFICATIONS FOR CAST IRON AND FINISHED CASTINGS.

WALTER WOOD, *Chairman.*
RICHARD MOLDENKE, *Secretary.*

NON-PRODUCERS (24).

Beckett, James A.
Colby, Albert Ladd.
Davidson, George M.
Diller, H. E.
DuComb, W. C., Jr.
Findley, A. I.
Gibbs, A. W.
Hatt, W. K.
Hildreth, P. S.
Howe, Henry M.
International Harvester Company, John G. Wood.
Job, Robert.
Kinkead, J. A.
Kreuzpointner, Paul.
Lanza, Gaetano.
MacPherran, R. S.
McKenna, Charles F.
Merriman, Mansfield.
Moldenke, Richard (*Secretary*).
Outerbridge, Alexander E., Jr.
Saunders, Walter M.
Sauveur, Albert.
Souther, Henry.
Touceda, Enrique.

PRODUCERS (19).

[1] American Locomotive Company, S. V. Hunnings.
Colorado Fuel and Iron Company, J. B. McKennan.
Cook, Edgar S.
Fackenthal, B. F.
[1] Flagg, Stanley G.
[1] Hayes, J. A.
Hearne, W. W.
Henshaw, J. O.
[1] Illinois Steel Company, P. E. Carhart.
[1] Johnson, R. K.
[1] Jones and Laughlin Steel Company, Willis L. King.
[1] Lobdell, William W.
[1] Olsen, Tinius.
Peckitt, Leonard.
[1] West, Thomas D.
[1] Wood, E. R., Jr.
Wood, F. W.
[1] Wood, Walter (*Chairman*).
Zehnder, C. H.

COMMITTEE A-4, ON HEAT TREATMENT OF IRON AND STEEL.

HENRY M. HOWE, *Chairman.*
ALBERT SAUVEUR, *Secretary.*

NON-PRODUCERS (6).

Bureau of Steam Engineering, U. S. N., Engineering Experiment Station, Engineer Officer, Philadelphia.
Campbell, William.
Howe, Henry M. (*Chairman*).
Sauveur, Albert (*Secretary*).
Stansfield, Alfred.
Stoughton, Bradley.

[1] These members of Committee A-3, classed as PRODUCERS, stand in the relation of PRODUCER to certain products, and in that of NON-PRODUCER to other products within the province of the Committee.

COMMITTEE A-4.—*Continued.*

PRODUCERS (4).

Bethlehem Steel Company,
E. O'C. Acker.
Kenney, E. F.
Midvale Steel Company,
Radclyffe Furness.
Unger, J. S.

COMMITTEE A-5, ON THE CORROSION OF IRON AND STEEL.

ALLERTON S. CUSHMAN, *Chairman.*
WILLIAM H. WALKER, *Secretary.*

NON-PRODUCERS (10).

Bureau of Construction and Repair,
U. S. N.,
Material Branch.
Bureau of Steam Engineering, U. S. N.,
Engineering Experiment Station.
Burgess, C. F.
Campbell, William.
Cushman, Allerton S. (*Chairman*).
Howe, Henry M.
Job, Robert.
Lyon, Frank.
Walker, William H. (*Secretary*).
Wickhorst, M. H.

PRODUCERS (6).

American Steel and Wire Company,
S. M. Rodgers.
Aupperle, J. A.
Buck, D. M.
Cooper, W. A.
Lukens Iron and Steel Company,
Charles L. Huston.
National Tube Company,
Frank N. Speller.

COMMITTEE A-6, ON THE MAGNETIC TESTING OF IRON AND STEEL.

CHARLES W. BURROWS, *Chairman.*

Beck, W. J.
Browne, Vere.
Capp, J. A.
Crocker-Wheeler Company,
R. B. Treat.
Follansbee Brothers Company,
J. G. Homan.
Linder, O.
Mathews, J. A.
Pinkerton, Andrew.
Sargent, G. W.
Skinner, C. E.

COMMITTEE A-7, ON THE TEMPERING AND TESTING OF STEEL SPRINGS.

HENRY SOUTHER, *Chairman.*

NON-PRODUCERS (12).

Bunnell, F. O.
Bureau of Standards,
James E. Howard.
Davis, Nathan H.
Hunnings, S. V.
Kinkead, J. A.

COMMITTEE A-7.—*Continued.*

NON-PRODUCERS.—(*Continued.*)

Koch, G. B.
Lanza, Gaetano.
Mahon, R. W.
Nelson, E. D.
Souther, Henry (*Chairman*).
Vauclain, J. L.
Wickhorst, M. H.

PRODUCERS (7).

American Steel Foundries, J. C. Davis.
Bright, H. DeH.
Carnegie Steel Company, Hugh P. Tiemann.
Carney, F. D.
Lukens, Alan.
McCrea, Archibald M.
Stevenson, A. A.

COMMITTEE A-8, ON STANDARD SPECIFICATIONS FOR COLD DRAWN STEEL.

C. E. SKINNER, *Chairman.*

NON-PRODUCERS (7).

Bureau of Steam Engineering, U. S. N., Inspector of Ordnance.
General Electric Company, J. A. Capp.
National Cash Register Company, F. O. Clements.
Remington Arms and Ammunition Company, Nathan A. Chase.
Standard Screw Company, E. H. Ehrman.
Westinghouse Electric and Manufacturing Company, C. E. Skinner (*Chairman*).
Winchester Repeating Arms Company, R. L. Penney.

PRODUCERS (6).

American Steel and Wire Company, S. M. Rodgers.
Cambria Steel Company, E. F. Kenney.
Carnegie Steel Company, E. T. Ickes.
Columbia Steel and Shafting Company, E. I. Parker.
Jones and Laughlin Steel Company, Jesse J. Shuman.
Union Drawn Steel Company, F. N. Beegle.

COMMITTEE A-9, ON ALLOY STEELS.

GEORGE L. NORRIS, *Chairman.*
WILLIAM CAMPBELL, *Secretary.*

NON-PRODUCERS (11).

Bureau of Steam Engineering, U. S. N., Engineer Officer, Philadelphia.
Burgess, C. F.
Campbell, William (*Secretary*).
Hillebrand, W. F.
Howe, Henry M.
Norris, G. L. (*Chairman*).
Sauveur, Albert.
Skinner, C. E.
Souther, Henry.
Stansfield, A.
Stoughton, Bradley.

COMMITTEEE A-9.—*Continued.*

PRODUCERS (8).

Abbott, R. R.
Carpenter Steel Company, J. H. Parker
Hall, John H.
Kenney, E. F.
Mathews, J. A.
Sargent, G. W.
Unger, J. S.
Zimmerschied, K. W.

COMMITTEE A-10, ON HARDNESS TESTS.

BRADLEY STOUGHTON, *Chairman.*

Boylston, H. M.
Douty, D. E.
Macgregor, J. S.
Waldo, Leonard.

B. ON NON-FERROUS METALS.

COMMITTEE B-1, ON STANDARD SPECIFICATIONS FOR COPPER WIRE.

J. A. CAPP, *Chairman.*

NON-PRODUCERS (6).

General Electric Company, J. A. Capp (*Chairman*).
MacPherran, R. S.
Viele, Blackwell and Buck, O. A. Havill.
Western Electric Company, G. Crossman.
Westinghouse Electric and Manufacturing Company, T. D. Lynch.
White and Company, J. G., C. D. Gray.

PRODUCERS (5).

American Brass Company, W. H. Bassett.
American Steel and Wire Company, J. F. Tinsley.
Roebling's Sons Company, J. A., H. J. Horne.
Standard Underground Cable Company, C. C. Baldwin.
Waclark Wire Company, F. W. Wallace.

COMMITTEE B-2, ON NON-FERROUS METALS AND ALLOYS.

WILLIAM CAMPBELL, *Chairman.*

Vice-Chairmen.

W. H. BASSETT
G. H. CLAMER
T. D. LYNCH
W. R. WEBSTER

NON-PRODUCERS (13).

Bragg, C. T.
Bureau of Steam Engineering, U. S. N., Inspection Division.
Campbell, William (*Chairman*).
Capp, J. A.
Harriman, N. F.

COMMITTEE B-2.—*Continued.*

NON-PRODUCERS.—(*Continued.*)

Hillebrand, W. F.
Jones, Jesse.
Lynch, T. D. (*Vice-Chairman*).
Metal Industry, The
J. L. Krom.
Smith, H. E.
Souther, Henry.
Sperry, E. S.
Zimmerschied, K. W.

PRODUCERS[1] (15).

Addicks, L.
Ajax Metal Company,
G. H. Clamer (*Vice-Chairman*).
American Brass Company,
W. H. Bassett (*Vice-Chairman*).
Antisell, F. L.
Cooper, J. B.
Corse, W. M.
Furst, E. W.
Goss, E. O.
Herreshoff, J. B., Jr.
Norris, G. L.
Spare, C. R.
Stone, G. C.
Thompson, G. W.
Thompson, J. F.
Webster, W. R. (*Vice-Chairman*).

C. ON CEMENT, LIME, AND CLAY PRODUCTS.

COMMITTEE C-1, ON STANDARD SPECIFICATIONS FOR CEMENT.

GEORGE F. SWAIN, *Chairman.*
GEORGE S. WEBSTER, *Vice-Chairman.*
RICHARD L. HUMPHREY, *Secretary.*

NON-PRODUCERS (15).

Booth, Garrett and Blair.
Dow, A. W.
Hoff, Olaf.
Humphrey, Richard L. (*Secretary*).
Maclay, W. W.
McKenna, Charles F.
Munsell, A. W.
Porter, J. Madison.
Richards, Joseph T.
Richardson, Clifford.
Sabin, L. C.
Spackman Engineering Company,
Henry S.,
Henry S. Spackman.
Swain, George F. (*Chairman*).
Voorhees, S. S.
Webster, George S. (*Vice-Chairman*).

PRODUCERS (9).

Boynton, C. W.
Dumary, L. Henry.
Gerstell, A. F.
Hagar, Edward M.
Harding, W. H.
Lesley, Robert W.
Lober, John B.
Newberry, Spencer B.
Seaman, Harry J.

[1] The members of Committee B-2, classed as PRODUCERS, stand in the relation of PRODUCER to certain products, and in that of NON-PRODUCER to other products within the province of the Committee.

COMMITTEE C-2, ON REINFORCED CONCRETE.

F. E. TURNEAURE, *Chairman.*
ROBERT W. LESLEY, *Vice-Chairman.*
RICHARD L. HUMPHREY, *Secretary.*

NON-PRODUCERS (13).

Fuller, W. B.
Heidenreich, E. Lee.
Humphrey, Richard L. (*Secretary*).
Lanza, Gaetano.
Marburg, Edgar.
Mills, C. M.
Moisseiff, Leon S.
Quimby, H. H.
Taylor, W. P.
Thompson, S. E.
Turneaure, F. E. (*Chairman*).
Wagner, Samuel T.
Webster, George S.

PRODUCERS (2).

Johnson, A. L.
Lesley, Robert W. (*Vice-Chairman*).

COMMITTEE C-3, ON STANDARD SPECIFICATIONS FOR BRICK.

A. V. BLEININGER, *Chairman.*
D. E. DOUTY, *Secretary.*

NON-PRODUCERS (9).

Bleininger, A. V. (*Chairman*).
Douty, D. E. (*Secretary*).
Emley, W. E.
Lawson, T. R.
Lazell, E. W.
Orton, Edward, Jr.
Talbot, Arthur N.
Testing Laboratory, City of St. Louis, Mont Schuyler.
Woolson, Ira H.

PRODUCER (1).

Blair, Will P.

COMMITTEE C-4, ON STANDARD SPECIFICATIONS AND TESTS FOR CLAY AND CEMENT SEWER PIPES.

RUDOLPH HERING, *Chairman.*
A. J. PROVOST, JR., *Vice-Chairman.*
E. J. FORT, *Secretary.*

NON-PRODUCERS (14).

Barbour, F. A.
Bleininger, A. V.
Eddy, Harrison P.
Fort, E. J. (*Secretary*).
Hering, Rudolph (*Chairman*).
Hill, C. D.
Howe, Malverd A.
Humphrey, Richard L.
Marston, A.
Provost, A. J., Jr. (*Vice-Chairman*).
Talbot, A. N.
Testing Laboratory, City of St. Louis Mont Schuyler.
Thompson, R. H.
Webster, George S.

COMMITTEE C-4.—*Continued.*

PRODUCERS (7).

Dickey, W. S.
Kaufman, Gustave.
Meriwether, Coleman.
Oberkirch, Frank.
Rossi, James C.
Starr, John J.
Wallace, John T.

COMMITTEE C-5, ON FIREPROOFING MATERIALS.

IRA H. WOOLSON, *Chairman.*
R. P. MILLER, *Secretary.*

Ewing, W. W.
Freeman, John R.
Hodge, H. W.
Macgregor, J. S.
Sommerville, C. W.
Thacher, Edwin.
Waid, D. E.

COMMITTEE C-6, ON STANDARD TESTS AND SPECIFICATIONS FOR DRAIN TILE.

A. MARSTON, *Chairman.*
ARTHUR N. TALBOT, *Vice-Chairman.*
J. T. STEWART, *Secretary.*

NON-PRODUCERS (8).

Bureau of Irrigation, United States, Samuel Fortier.
Chatburn, George R.
Hering, Rudolph.
Marston, A. (*Chairman*).
Stewart, J. T. (*Secretary*).
Talbot, Arthur N. (*Vice-Chairman*).
Testing Laboratory, City of St. Louis, Mont Schuyler.
Turneaure, F. E.

PRODUCERS (8).

Atwood, P. H.
Bingham, L. L.
Boynton, C. W.
Child, J. Leo.
Gates, A. W.
Hoover, W. C.
National Association of Cement Users Richard L. Humphrey.
Rawson, Charles A.

COMMITTEE C-7, ON STANDARD SPECIFICATIONS FOR LIME.

H. S. SPACKMAN, *Chairman.*
E. L. CONWELL *Secretary.*

NON-PRODUCERS (9).

Berry, H. C.
Emley, W. E.
Force, H. J.
Hunt and Company, R. W., J. F. Davis.
Lazell, E. W.
Macgregor, J. S.
Skinner, H. J.
Spackman, H. S. (*Chairman*).
Westinghouse, Church, Kerr and Company, C. M. Chapman.

COMMITTEE C-7.—*Continued.*

PRODUCERS (6).

Aluminate Patents Company,
E. L. Conwell (*Secretary*).
National Lime Manufacturers' Association,
Carson. W. E.
Cobb, C. W. S.
Kelley Island Lime and Transportation Company,
L. Hitchcock.
McLanahan, J. K., Jr.
Warner, Charles.

D. ON MISCELLANEOUS MATERIALS.

COMMITTEE D-1, ON PRESERVATIVE COATINGS FOR STRUCTURAL MATERIALS.

S. S. VOORHEES, *Chairman.*
G. B. HECKEL, *Vice-Chairman.*
G. W. THOMPSON, *Secretary.*

NON-PRODUCERS (33).

Aiken, A. W.
Akin, Thomas B.
Boughton, E. W.
Bureau of Construction and Repair, U. S. N.,
Material Branch.
Cushman, Allerton S.
Davidson, George M.
Force, H. J.
Froehling and Robertson,
Andrew Robertson.
Gardner, Henry A.
Gibboney, James H.
Gill, A. H.
Hume, A. P.
Job, Robert.
Lawrie, J. W.
Macnichol, Charles.
McDonnell, M. E.
McIlhiney, P. C.
Millwood, J. P.
Ramage, J. C.
Riddle, G. W.
Rogers, Allen.
Sadtler and Son, S. P.
Smith, F. P.
Smith, H. E.
Tassin, Wirt.
Van Gundy, C. P.
Voorhees, S. S. (*Chairman*).
Walker, Percy H.
Walker, William H.
Westinghouse, Church, Kerr and Company,
C. M. Chapman.
White, A. H.
Wickhorst, M. H.
Young, J. B.

PRODUCERS (26).

Dixon Crucible Company,
M. MacNaughton.
Eisenschiml, Otto.
Evans, S. M.
Forrest, C. N.
Heckel, G. B. (*Vice-Chairman*).
Ingalls, F. P.
Kohr, D. A.
Lane, F. A.
Lindsay, R. W.
Low, Frank S.
Lowe Brothers Company,
Houston Lowe.
Lucas and Company, John,
L. P. Nemzek.
Mannhardt, H.
Neal, C. S.
Perry, R. S.
Pickard, Glenn H.
Polk, Anderson.

COMMITTEE D-1.—*Continued.*

PRODUCERS.—(*Continued.*)

Rigg, G.
Sabin, A. H.
Schaeffer, J. A.
Sherwin-Williams Company, E. C. Holton.
Thompson, G. W. (*Secretary*).
Toch, Maximilian.
United States Gutta Percha Paint Company, Herbert W. Rice.
White, G. D.
Wilhelm Company, The A., Walter S. Davis.

COMMITTEE D-2, ON STANDARD TESTS FOR LUBRICANTS.

A. H. GILL, *Chairman.*
J. M. JEFFERS, *Secretary.*

NON-PRODUCERS (10).

Allen, I. T.
Bureau of Steam Engineering, U. S. N., Engineering Experiment Station.
Converse, W. A.
Dow, A. W.
Dunbar, W. A.
Gill, A. H. (*Chairman*).
Hume, A. P.
Jeffers, J. M. (*Secretary*).
Penniman and Browne, A. L. Browne.
Stratton, S. W.

PRODUCERS (6).

Baum, George.
Conradson, P. H.
Gray, J. L.
Gray, T. T.
Pew, J. H.
Taber, George H.

COMMITTEE D-3, ON STANDARD METHODS OF ANALYSIS OF FATS AND OILS.

C. N. FORREST, *Chairman.*

Frank, Jerome W.
Thompson, G. W.

COMMITTEE D-4, ON STANDARD TESTS FOR ROAD MATERIALS.

LOGAN WALLER PAGE, *Chairman.*
PRÉVOST HUBBARD, *Secretary.*

NON-PRODUCERS (14).

Blanchard, A. H.
Broadhurst, W. H.
Crosby, W. W.
Dow, A. W.
Greenman, R. S.
Hatt, W. K.
Holmes, J. A.
Hubbard, Prévost (*Secretary*).

COMMITTEE D-4.—*Continued.*

NON-PRODUCERS.—(*Continued.*)

Hunter, Joseph W.
Johnson, Arthur N.
Marston, A.
Page, Logan Waller (*Chairman*).
Richardson, Clifford.
Smith, F. P.

PRODUCERS (19).

American Asphaltum and Rubber Company,
H. B. Pullar.
Chamberlain, A. B.
Church, S. R.
Cobb, E. B.
Drowne, H. B.
Forrest, C. N.
Fulweiler, W. H.
Goldbeck, A. T.
Hemstreet, G. P.
Kershaw, W. H.
Reeve, C. S.
Sargent, P. D.
Sharples, P. P.
Sommer, Albert.
Spencer, Herbert.
Standard Asphalt and Rubber Company,
W. A. Levering.
Thompson, S. E.
Tomkins, Calvin.
Warren Brothers Company,
A. E. Schutte.

COMMITTEE D-5, ON STANDARD SPECIFICATIONS FOR COAL.

J. A. HOLMES, *Chairman.*
G. S. POPE, *Secretary.*

NON-PRODUCERS (31).

Bailey, Edwin G.
Belden, A. W.
Blauvelt, W. H.
Brady, William.
Bureau of Steam Engineering, U. S. N., Inspection Division.
Bush, B. F.
Capp, J. A.
Carney, F. D.
Fernald, R. H.
Forstall, Alfred E.
Gibbs, A. W.
Goodenough, Walter.
Goss, W. F. M.
Hagar, Edward M.
Harris, J. R.
Holmes, J. A. (*Chairman*).
Hume, A. P.
Lesley, Robert W.
Moldenke, Richard.
Orton, Edward, Jr.
Parr, S. W.
Pope, G. S. (*Secretary*).
Randall, D. T.
Rice, George S.
Roberts and Schaefer Company,
Frank E. Mueller.
Robinson, C. S.
Storrs, L. S.
United Gas Improvement Company
Walton Clark.
Voorhees, S. S.
White, Alfred H.
Woodwell, J. E.

PRODUCERS (13).

Adams, H. C.
Bullitt, W. C.
Fisher, Thomas.
Fleming, Henry S.
Garrison, O. L.
Haas, Frank R.
Jones, John H.
Kemmerer, John L.
McCreath and Son, Andrew S.,
Andrew S. McCreath.
Schleuderberg, G. W.
Scholz, Carl.
Toulmin, Priestley.
Wadleigh, F. R.

COMMITTEE D-6, ON STANDARD SPECIFICATIONS FOR COKE.

J. A. HOLMES, *Chairman.*
ALBERT LADD COLBY, *Secretary.*

NON-PRODUCERS (13).

Anaconda Copper Mining Company,
E. P. Mathewson.
Belden, A. W.
Bole, William A.
Colby, Albert Ladd (*Secretary*).
Cook, Edgar S.
Fackenthal, B. F., Jr.
Haldeman, Horace L.
Holmes, J. A. (*Chairman*).
Johnson, R. K.
Lynch, T. D.
Moldenke, Richard.
Souther, Henry.
Wood, Walter.

PRODUCERS (7).

Blauvelt, W. H.
Haas, Frank R.
Lynch, Thomas.
Page, W. N.
Rothstein, E. K.
Schniewind, F.
Wentz, Daniel B.

COMMITTEE D-7, ON STANDARD SPECIFICATIONS FOR THE GRADING OF STRUCTURAL TIMBER.

HERMANN VON SCHRENK, *Chairman.*

Bureau of Construction and Repair,
U. S. N.,
Material Branch.
Elzner, A. O.
Lohmann, H. W.
Robinson, A. F.
Rosenheim, A. F.
Russell, E. J.

COMMITTEE D-8, ON WATERPROOFING MATERIALS.

W. A. AIKEN, *Chairman.*
CYRIL DE WYRALL, *Secretary.*

NON-PRODUCERS (9).

Aiken, W. A. (*Chairman*).
Davies, J. V.
DeWyrall, Cyril (*Secretary*).
Force, H. J.
Gaines, R. H.
Munsell, A. W.
Schreiber, Martin.
Walter, L. W.
Westinghouse, Church, Kerr and
Company,
C. M. Chapman.

PRODUCERS (5).

Barrett Manufacturing Company,
W. S. Babcock.
DeKnight, E. W.
Standard Asphalt and Rubber Company,
W. H. Lawrence.
Toch, Maximilian.
Warren Brothers Company,
A. E. Schutte.

COMMITTEE D-9, ON STANDARD TESTS OF INSULATING MATERIALS.

C. E. SKINNER, *Chairman.*

NON-PRODUCERS (7).

Bureau of Standards,
H. B. Brooks.
Bureau of Steam Engineering, U. S. N.,
Electrical Division.
Commonwealth-Edison Company,
E. O. Schweitzer.
Electrical Testing Laboratories,
F. M. Farmer.
General Electric Company,
J. A. Capp.
Western Electric Company,
G. Crossman.
Westinghouse Electric and Manufacturing Company,
C. E. Skinner (*Chairman*).

PRODUCERS (5).

B. F. Goodrich Company,
William C. Geer.
Locke Insulator Company,
John S. Lapp.
Schenectady Varnish Company,
W. H. Wright.
Sherwin-Williams Company, The
A. P. Johnstone.
Standard Underground Cable Company,
H. W. Fisher.

COMMITTEE D-10, ON STANDARDIZING EXPLOSIVES.

C. E. MUNROE, *Chairman.*

NON-PRODUCERS (3).

Dunn, B. W.
Holmes, J. A.
Munroe, C. E. (*Chairman*).

PRODUCERS (3).

Barksdale, H. N.
Blum, A. C.
Fay, A. G.

COMMITTEE D-11, ON STANDARD SPECIFICATIONS FOR RUBBER PRODUCTS.

E. B. TILT, *Chairman.*
E. A. BARRIER, *Secretary.*

NON-PRODUCERS (14).

Barrier, E. A. (*Secretary*).
Blakeley, A. G.
Bureau of Construction and Repair,
U. S. N.
Bureau of Steam Engineering, U. S. N.
Farmer, F. M.
Force, H. J.
International Paper Company
C. F. Rhodes.
McFarland, H. B.
Onderdonk, J. R.
Pierce, Dana.
Skinner, C. E.
Tilt, E. B. (*Chairman*).
Young, C. D.
Young, J. B.

COMMITTEE D-11.—*Continued.*

PRODUCERS (6).

Boggs, C. R.
Cutler, D. A.
Fellows, J. W.
Geer, W. C.
General Electric Company
W. S. Clark,
Whipple, Dorris.

COMMITTEE D-12, ON PETROLEUM PRODUCTS.

(*In course of organization.*)

E. ON MISCELLANEOUS SUBJECTS.

COMMITTEE E-1, ON STANDARD METHODS OF TESTING.

GAETANO LANZA, *Chairman.*

Bostwick, W. A.
Bureau of Steam Engineering, U. S. N., Engineering Experiment Station, Inspection Division.
Cambria Steel Company, G. E. Thackray.
Campbell, William.
Chamberlain, G. D.
Deans, John S.
Diller, H. E.
Fay, Henry.
Hatt, W. K.
Howard, J. E.
Howe, Henry M.
Hume, A. P.
Humphrey, Richard L.
Job, Robert.
Linder, O.
Merriman, Mansfield.
Moldenke, Richard.
Nelson, E. D.
Talbot, H. P.
Vauclain, J. L.
Woolson, Ira H.

COMMITTEE E-2, ON ELECTRICAL STANDARDS.

(*In course of organization.*)

COMMITTEE E-3, ON THE DEFINITION OF THE TERM "MODULUS OF ELASTICITY" IN ITS APPLICATION TO MATERIALS, INCLUDING NON-FERROUS METALLIC METALS AND THEIR COMBINATIONS.

LEONARD WALDO, *Chairman.*

Howard, James E.
Whittemore, H. L.

COMMITTEE E-4, ON METHODS OF SAMPLING AND ANALYSIS OF COAL.

(Forming part of a joint committee on this subject with a committee of the American Chemical Society.)

Dickinson, G. C.
Haas, Frank R.
Parr, S. W. (*Chairman*).
Voorhees, S. S.

COMMITTEE E-5, ON RULES GOVERNING THE FORM BUT NOT THE SUBSTANCE OF SPECIFICATIONS.

EDGAR MARBURG, *Chairman.*
C. E. SKINNER, *Vice-Chairman.*

Representing Committee	
A-1	W. R. Webster.
A-2	S. V. Hunnings.
A-3	Walter Wood.
A-4	Albert Sauveur.
A-5	A. S. Cushman.
A-6	C. W. Burrows.
A-7	Henry Souther.
A-8	F. O. Clements.
A-9	Wm. Campbell.
A-10	Bradley Stoughton.
B-1	J. A. Capp.
B-2	T. D. Lynch.
C-1	Richard L. Humphrey.
C-3	I. H. Woolson.
C-4	Rudolph Hering.
C-5	I. H. Woolson.
C-6	A. Marston.
C-7	H. S. Spackman.
D-2	A. H. Gill.
D-4	L. W. Page.
D-5	G. S. Pope.
D-6	A. L. Colby.
D-7	H. von Schrenk.
D-9	C. E. Skinner (*Vice-Chairman*).
D-10	H. M. Barksdale.
D-11	E. B. Tilt.
E-1	G. Lanza.
Ex-Officio,	Edgar Marburg (*Chairman*).

REGULATIONS GOVERNING TECHNICAL COMMITTEES.

NOTE.—By action of the Executive Committee on January 6, 1912, the responsibility for the general Regulations Governing Technical Committees is vested in Committee E-5 on Regulations Governing the Form but not the Substance of Specifications, with the understanding (1) that a proposed change in these Regulations originating with Committee E-5 shall be subject to approval by the Executive Committee of the Society; and (2) that the Executive Committee of the Society shall make no changes in these Regulations without first referring the same to Committee E-5.

Creation.—The creation of a technical committee shall be subject to the authorization of the Executive Committee, acting either on a recommendation adopted by majority vote at an annual meeting of the Society, or on its own initiative.

Appointments.—Appointments on technical committees shall be made by the Executive Committee subject to the following provisions:

1. On committees dealing with subjects having a commercial bearing, either an equal numeric balance shall be maintained between the representatives of consuming and producing interests; or the former may be allowed to predominate with the acquiescence of the latter. Unattached experts shall be classed with the representatives of consuming interests.
2. Additional appointments on existing committees shall be made only on the recommendation of, or with the approval of, such committees.
3. Only members of the Society shall be eligible, in general, to appointment on committees, although exceptions may be authorized by the Executive Committee in favor of representatives of government branches or other societies.

Preliminary Organizations.—The President of the Society will appoint the chairman *pro tem.* of a new committee from the representatives of the consuming interests and unattached experts. The chairman *pro tem.*, after communicating with the other members of the committee, will fix the place and time of the first

meeting .He may, at his discretion, appoint one or more members of the committee to prepare matter in advance for consideration at that meeting or he may prepare such matter himself. This procedure is recommended as calculated to economize time at the meeting and to afford a definite basis for discussion.

Permanent Organization.—At the first meeting of a committee a permanent organization shall be effected by the election of a permanent chairman from among the representatives of consuming interests and unattached experts, and such other officers and sub-committees as the committee may desire. The duties and powers assigned to these officers and sub-committees, and the details of management and administration in general, shall be at the discretion of each committee, subject to the limitations of these regulations.

Reports.—The reports of technical committees shall be presented at the annual meetings. Reports embodying any features on which specific action on the part of the Society is recommended by the committee, must first have been submitted to letter ballot of the committee, and such features must have received the approval of the majority of those voting. Dissenting members shall have the right to present minority reports individually or jointly.

Specifications.—Proposed new and standard specifications or the proposed amendment of existing specifications must originate in the particular committee within whose province such specifications properly belong. No action affecting specifications shall be taken by any technical committee except at meetings called for that purpose. Action at such meetings shall be subject to majority vote of those voting, and subsequently to majority vote of those voting on letter ballot of the entire committee. Dissenting members shall have the right to present minority reports, individually or jointly, at the annual meeting of the Society at which the majority report is presented.

Any recommendation affecting specifications must be transmitted to the Secretary of the Society at least eight weeks in advance of the date of the annual meeting, and copies of these recommendations, in printed form, must be mailed by the Secretary to every member of the Society not less than four weeks before the annual meeting, so that members may come to the meeting prepared to discuss such recommendations, and that members not intending to be present at the meeting may contribute discussions by letter.

Any recommendations affecting specifications presented by the

appropriate committees at the annual meetings of the Society may be amended by a majority vote of those voting, and the final adoption of new or amended specifications shall be subject to the following procedure:

1. Approval at an annual meeting by two-thirds vote of those voting.
2. Approval by letter ballot of the Society by two-thirds vote of those voting.

Cooperation with Other Committees.—A committee may, at its discretion, invite the cooperation of committees of other societies on like or cognate subjects, provided such relations shall entail no obligations at variance with these regulations, and shall impose no restrictions upon the free and independent action of the committee.

A committee desiring to bring about the appointment of similar committees by other societies for purposes of cooperation shall address a recommendation to that effect to the Executive Committee and, on the approval of the latter, negotiations to the desired end shall be conducted on behalf of the Executive Committee by the Secretary of the Society.

Publications.—Committees shall have no right to issue matter for publication through other than the regular Society channels, unless so authorized, for exceptional reasons, by the Executive Committee.

Current Expenses.—The current expenses of committees for stationery and postage will be assumed by the Society. Stationery of standard form will be furnished by the Secretary of the Society on application of the chairman or secretary of a committee. Expenses for postage will be paid by the Treasurer of the Society on vouchers approved by the chairman of a committee.

Extraordinary Expenses.—Expenses for items other than stationery and postage will not be assumed by the Society, unless such expenditures were incurred in pursuance of authorization of the Executive Committee, on recommendation of the chairman of the committee concerned, and within amounts specifically fixed by the Executive Committee.

Special Funds.—Committees engaged on subjects having a commercial bearing shall be authorized to solicit contributions from manufacturers towards research funds. Contributions from consumers to funds for this and other purposes shall be solicited only by the Executive Committee. All funds thus

collected shall be transmitted to the Treasurer of the Society and deposited by him in bank and placed to the credit of the committees on the books of the Society, subject to disbursement only on vouchers signed by the chairman of the committee concerned.

Salaries and Fees.—Committees shall not be authorized to pay salaries or professional fees in any form to any of their officers or members. Assistants in connection with research work may be engaged at salaries or special compensation fixed by the committees concerned, provided that funds for such salaries or compensations shall previously have been deposited with the Treasurer of the Society. Payments for such purposes shall be made by the Treasurer of the Society only on vouchers approved by the chairman of the committee concerned.

Discharge of Committees.—Technical committees may be discharged by the Executive Committee, either at their own request or with their consent, on the completion of the work for which they were appointed or in consequence of protracted inactivity. A technical committee which fails to present a report at three successive annual meetings of the Society will be required to show cause why it should not be discharged in a written communication to the Executive Committee.

THE INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.

OFFICERS.

Acting President.

HENRY M. HOWE.

Vice-Presidents.

A. MARTENS. N. BELELUBSKY.

A. MESNAGER.

MEMBERS OF COUNCIL.

Every country having a membership of twenty or more in the Association is entitled to a representative on the Council. For those having a membership of less than twenty, mandataries are appointed by the Council.

Life Members.

FRANZ BERGER. ALEXANDER FOSS.

Elected Members.

Australia—W. H. WARREN.
Austria—B. KIRSCH.
Belgium—A. GREINER.
Denmark—H. I. HANNOVER.
France—A. MESNAGER.
Germany—A. MARTENS.
Great Britain—G. C. LLOYD.
Holland—L. BIENFAIT.
Hungary—A. REJTÖ.
Italy—S. CANEVAZZI.
Norway—N. C. IHLEN.
Roumania—C. M. MIRONESCO.
Russia—N. BELELUBSKY.
Spain—J. MARVA Y. MAYER.
Sweden—J. O. ROOS AF HJELMSÄTER.
Switzerland—F. SCHÜLE.
United States of America—HENRY M. HOWE.

MANDATARIES.

Brazil—A. F. SONZA DE PAULA.
Canada—MILTON HERSEY.
China—K. Y. KWONG.
Finland—CH. LINDBERG.
Japan—D. SAITO.
Luxembourg—M. E. BIAN.
Portugal—J. DA P. CASTANHEIRA DAS NEVES.
Servia—M. MILASINOVIC.

General Secretary.

ERNST REITLER.

Nordbahnstrasse 50, Vienna, II/$_2$, Austria.

Communications for the International Association should be directed to the International Association for Testing Materials, Nordbahnstrasse 50, Vienna, II/$_2$, Austria.

THE INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.

BY-LAWS.

Adopted at the Budapest Congress, 1901.
Amended at the Brussels Congress, 1906, and at the Copenhagen Congress, 1909.

SECTION 1. The Association shall be called "THE INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS."

SEC. 2. The objects of the Association are: the development and unification of standard methods of testing; the examination of the technically important properties of materials of construction and other materials of practical value, and also the perfecting of apparatus used for this purpose.

These objects will be furthered:

1. By the Congresses and other meetings of the Association.
2. By the publication of an official Journal.
3. By any other means that may appear desirable.

SEC. 3. The funds necessary for carrying out the purposes mentioned in Section 2 will be raised by

1 The annual subscriptions of members.
2. Profits from the official Journal.
3. Other contributions.

SEC. 4. Any person can become a member upon being proposed by two members of the Association.

Official bodies and technical societies can enter direct on their sending in their application for membership.

Applications for membership must be sent in writing to the President or to a member of the Council.

Resignations of membership must also be sent in the same way.

SEC. 5. It is the duty of every member to further the interests of the Society to the best of his ability.

Every member is required to pay an annual subscription of at least 8 Mks. =8 shillings = $2.00.*

* Subscriptions are to be paid to the duly appointed collectors in each country, the card of membership serving as a receipt. Subscriptions not paid by the first of July are collected through the post-office.

The Council is authorized to increase the annual subscription in order to cover extraordinary expenses incurred in the interests of the Association.

Sec. 6. Every member has the right to obtain the "Proceedings" of the Association, during the period for which his subscription has been paid.

Sec. 7. The Association will hold a Congress, as a rule, every second year.

The arrangements for the Congresses will be discussed in General Meetings and in meetings of the different sections.

Sections will be formed for the different groups of materials as may be considered necessary.

At present there are three sections:

I. Metals.

II. Natural and artificial building stones, cements and mortars.

III. Other materials of practical value.

Any special questions relating to the subjects of the different sections will be considered at sectional meetings.

The members assisting at the sectional debates, under the presidency of a member of the Council, will appoint the committees of the different sections.

The results of the deliberations of the different sections must be communicated at a General Meeting, which will pass resolutions embodying the proposals of the sections.

Reports of Commissions, proposals of the Council and other matters to be laid before the Congress, will be printed in German, French and English, and will be sent (in the language preferred) to all members who have announced their intention of taking part in the Congress, within fourteen days before the meeting of the Congress, if possible.

The decisions of the Congress will be printed in all three languages and sent to all members of the Association.

Sec. 8. The Council of the Association will transact all necessary business connected with the Association.

The Council will consist of the President and the duly elected members.

Every country represented in the Association by at least twenty members has the right to elect one member as member of the Council. For those countries where the number of members

is under twenty, the Council appoints a Mandatary who takes part in the Council's Meeting in an advisory capacity.

The President will be elected by the Congress, the Council by the members belonging to the different countries.

Till such election has taken place the former members of the Council remain in office.

The names of proposed new members of the Council have to be communicated to the President before each Congress.

The two Vice-Presidents will be elected by the Council from among its own members.

The Council has the power to elect Past Presidents as permanent members of Council.

The Council is entitled to transact business when it has been duly called together according to rule and when the President or one of the Vice-Presidents is present.

Retiring members of the Council are eligible for re-election.

If a member of the Council resigns during his term of office, the President shall immediately direct the election of a successor by the members belonging to the country in question.

In the event of the death or resignation of the President, the Council will appoint one of its members to carry on the presidential duties till the next Congress.

The term of office of the Council lasts from one Congress till the next.

Sec. 9. The business of the Association will be attended to by a salaried General Secretary under the direction of the President.

The members of the Council will attend to the business of the Association in the country which they represent.

Sec. 10. The resolutions of the Congresses on technical questions merely serve to express the opinion of the majority. They are therefore in the form of recommendations and are in no way binding.

Sec. 11. The resolutions of the Congresses can only be carried if at least three-fourths of the recorded votes are in favor of them. Every member of the Association present, as well as every representative of official bodies and technical societies, has one vote.

The rights and duties of a member of the Association are not altered by the fact of his belonging at the same time to a national or other Association, which Association is itself a member of the International Association.

Sec. 12. The technical problems to be considered by the Association will be decided upon by the Congresses and by the Council, and will be duly referred to commissions or referees appointed by the Council.

Sec. 13. The Council draws up its own regulations according to the By-Laws of the Association and to the needs which may from time to time present themselves.

Sec. 14. In the event of the Association being dissolved, any funds belonging to it will be handed over to the "International Red Cross Association."

THE INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.

Technical Problems, Committees[1] and Referees.

As constituted in March, 1912.

A. METALS.

Problem 1.—On the basis of existing specifications, to seek methods and means for the introduction of international specifications for testing and inspecting iron and steel of all kinds. (Proposed at the Zurich Congress, 1895; enlarged at the Budapest Congress, 1901.)

Committee:

Chairman.—A. Rieppel, Aeussere Cramer-Klettstrasse 12, Nuremburg, Germany.

American Members.—Carnegie Steel Company; Henry M. Howe; Paul Kreuzpointner; Richard Moldenke; William R. Webster; Walter Wood.

Problems 1a and 1b.—On the basis of unified specifications recognized in the various countries, to attempt the introduction of international unified specifications for iron and steel of all kinds. (Drawn up at the Twentieth and Twenty-first Council's Meeting, 1910.)

Committee 1a, on Steel and Steel Products:

Chairman.—A. Rieppel, Aeussere Cramer-Klettstrasse 12, Nuremburg, Germany.

American Members.—W. A. Bostwick; William R. Webster.

[1] The names of only the Chairmen, the Vice-Chairmen, and American Members of International Committees are here given.

Committee 1b, on Cast Iron and Cast-Iron Products.

Chairman.—W. Brüggemann, Dortmund, Germany.
American Members.—Richard Moldenke; Walter Wood.

Problem 4.—Methods for testing welds and weldability. (Proposed at the Zurich Congress, 1895.)

Problem 24.—On uniform nomenclature of iron and steel. (Resolution of Council, February 3, 1901.)

Committee:

Chairman.—Henry M. Howe, Broad Brook Road, Bedford Hills, N. Y.
Vice-Chairmen.—L. Lévy, Rue de La Rochefoucauld 19, Paris, France; D. Tschernoff, Rue Pessotschnaya 25, St. Petersburg, Russia.
Secretary.—Albert Sauveur, Rotch Building, Harvard University, Cambridge, Mass.
American Members.—American Institute of Mining Engineers, represented by R. Hibbard; American Iron and Steel Institute, represented by C. Kirchhoff; American Society of Mechanical Engineers; William Campbell; Joseph W. Richards; Hugh P. Tiemann.

Problem 25.—To draw up methods of testing cast iron and finished castings. (Proposed at the Budapest Congress, 1901; altered at the Twentieth Council's Meeting in the sense of the Copenhagen Congress resolution.)

Problem 26.—Collection of data which permit the ascertaining of relations between the properties revealed by impact tests on notched bars and the behavior of the pieces in service. Comparison of results obtained with various apparatus. (Resolution of the Copenhagen Congress, 1909.)

Chairman.—G. Charpy, Montluçon, France.

Problem 27.—Ascertaining the relations between the different methods for determining hardness; fixing the numerical values thus obtained representing the different properties of metals; and determining which method gives the results most in harmony with the wearing properties and useful hardness in practice. (Proposed at the Budapest Congress, 1901.)

Problem 28.—The consideration of the magnetic and electric properties of materials in connection with their mechanical testing. (Proposed at the Budapest Congress, 1901.)

Referee.—Charles W. Burrows, Bureau of Standards, Washington, D. C.

Problem 38.—The principles for specifications of copper and copper alloys are to be studied. (Proposed at the Brussels Congress, 1906; enlarged at the Copenhagen Congress, 1909.)

Committee:

Chairman.—Léon Guillett, 8, Avenue des Ternes, Paris, XVIIe, France.

American Members.—C. E. Skinner; H. E. Diller; William Campbell.

Problem 44.—Relations between the chemical composition, the thermic treatment, and the properties of special steels. (Drawn up at the Twentieth Council's Meeting, 1910.)

Problem 45.—Studying methods for determining the enclosures, their influence upon the mechanical properties of metallurgical products, and for the study of this question on the whole. (Drawn up at the Copenhagen Congress, 1909.)

Problem 46.—Drawing up of unified tests for the resistance of metals to mechanical wear. (Proposed at the Copenhagen Congress, 1909.)

Problem 47.—Methods for ascertaining the resistance of metals to alternating stresses. (Drawn up at the Twentieth Council's Meeting, 1910.)

Problem 48.—Influence of increased temperature on the ductility and malleability of metals. (Drawn up at the Twentieth Council's Meeting, 1910.)

Problem 49.—Classification of pig iron. To ascertain how far specification on analysis may be substituted for the method of grading by fracture appearance. (Drawn up at the Copenhagen Congress, 1909.)

Referred to Committee 1b.

Problem 53.—Defining the microscopic constituents of iron and steel. (Drawn up at the Twenty-first Council's Meeting, 1910.)

Committee:

Chairman.—Henry M. Howe, Bound Brook Road, Bedford Hills, N. Y.

Secretary.—Albert Sauveur, Rotch Building, Harvard University, Cambridge, Mass.

Problem 54.—To examine all available data showing the relation between the working stress (*a*) on structural members which have failed and (*b*) on those which have not failed, on one hand, and the six properties, elastic limit, yield point, proportionality limit, tensile strength, resistance as notched bars, and endurance, on the other hand: with the purpose of learning which of these six properties is the most closely related to the safe working stress in the several chief classes of structures. (Proposed at the Twenty-first Council's Meeting, 1910.)

B. HYDRAULIC CEMENTS, STONES, AND CONCRETE.

Problem 7.—Investigations on the weathering resistance of building stones; the influence of smoke, especially sulphurous acid, on building stones; the weathering qualities of roofing slates. (Proposed at the Zurich Congress, 1895.)

Committee:

Chairman.—A. Hanisch, Währingstrasse 59, Vienna, IX, Austria.

Vice-Chairman.—P. Larivière, 170, Quai de Jemmapes, Paris, Xe, France.

American Member.—Mansfield Merriman.

Problem 9.—On rapid methods for determining the strength of hydraulic cements. (Proposed at the Zurich Congress, 1895.)

Committee:

Chairman.—F. Berger, Schottenfeldgasse 37, Vienna, VII, Austria.
American Members.—W. W. Maclay; Charles F. McKenna.

Problem 10.—To digest and evaluate the resolutions of the conferences of 1884-1893 concerning the adhesive qualities of hydraulic cements. (Proposed at the Zurich Congress, 1895.)

Problem 11.—To establish methods for testing puzzolanas, with the object of determining their value for mortars. (Proposed at the Zurich Congress, 1895.)

Committee:

Chairman.—G. Herfeldt, Andernach a. Rh., Germany.
Vice-Chairman.—C. Segré, Ancona, Italy.
American Member.—A. Lundteigen.

Problem 12.—Investigation on the behavior of cements as to time of setting, and on the best method for determining the beginning and the duration of the process of setting, with special reference to ball pressure tests. (Proposed at the Zurich Congress, 1895; enlarged in conformity with the resolution of the Budapest Congress, 1901; completed at the Twentieth Council's Meeting, 1910.)

Problem 30.—Determination of the simplest method for the separation of the finest particles in Portland cement by liquid and air processes. (Proposed at the Budapest Congress, 1901.)

Committee:

Chairman.—M. Gary, Gross-Lichterfelde, W., Germany.
American Member.—Henry S. Spackman Engineering Company.

Problem 31.—On the behavior of cement in sea water. (*a*) Additional information to the reports presented at the Copenhagen Congress, 1909, and information on the effect of sea water on Portland-cement sea structures of more than twenty-five years' standing.

(*b*) Study of the effect of sea water on specially prepared cements. (Proposed at the Budapest Congress, 1901; completed at the Copenhagen Congress, 1909.)

Referee to Problem (*a*).—E. Leduc, Paris, France.

Committee (*b*):

Chairman.—E. Leduc, Paris, France.
American Member.—Robert W. Lesley.

Problem 32.—On accelerated tests of the constancy of volume of cements. (Decision of the Zurich Congress, 1895.)

Problem 40.—Study of the unification of specifications for gypsum. (Proposed at the Brussels Congress, 1906.)

Problem 41.—Investigations of reinforced concrete. (Proposed at the Brussels Congress, 1906.)

Committee:

Chairman.—F. Schüle, Polytechnikum, Zurich, Switzerland.
Vice-Chairmen.—M. Germelmann, W. Wilhelmstrasse 80, Berlin; A. N. Talbot, University of Illinois, Urbana, Ill.
American Members.—Richard L. Humphrey; F. E. Turneaure.

Problem 42.—Uniform tests of hydraulic cements by prisms, and determination of a standard sand. (Proposed at the Brussels Congress, 1906.)

Committee:

Chairman.—F. Schüle, Polytechnikum, Zurich, Switzerland.
American Member.—Richard L. Humphrey.

Problem 50.—On the influence of the composition of the mortar and the quality of the building stone on the weathering of masonry. (Proposed at the Copenhagen Congress, 1909.)

Chairman.—A. van der Kloes, Delft, Holland.

C. MISCELLANEOUS.

Problem 18.—On the methods of testing the protective power of paints used on metallic structures. (Proposed at the Zurich Congress, 1895.)

Rejeree.—Allerton S. Cushman, Institute of Industrial Research, Washington, D. C.

Problem 34.—Fixing a uniform definition and nomenclature of the bitumens. (Proposed at the Budapest Congress, 1901.)

Rejeree.—D. Holde, Gross-Lichterfelde, W., Germany.

Problem 35.—Study of the methods of testing caoutchouc. (Proposed at the Budapest Congress, 1901.)

Chairman.—E. Camerman, 31 Square-Guttenberg, Brussels, Belgium.

Problem 39.—Study of the principles of specifications of oil for technical purposes. (Proposed at the Brussels Congress, 1906.)

Committee:

Chairman.—M. Albrecht, Hamburg, Germany.
Vice-Chairman.—E. Camerman, 31 Square-Guttenberg, Brussels, Belgium.
American Member.—A. H. Gill.

Problem 51.—Examination into the desirability of making wood tests on larger pieces containing defects or variations in structural form instead of limiting the tests to small perfect pieces. (Drawn up at the Copenhagen Congress, 1909.)

Referee.—M. Rudeloff, Gross-Lichterfelde, Germany.

Problem 52.—Nomenclature of certain technical qualities connected with internal strains. (Drawn up at the Twentieth Council's Meeting, 1910.)

Chairman.—A. Mesnager, 182 Rue de Rivoli, Paris, I, France.

ANNUAL REPORT OF THE EXECUTIVE COMMITTEE,

In pursuance of action at the last annual meeting, and with a view of not trenching on the prospective Sixth Congress of the International Association for Testing Materials, to be convened in New York, September 3-7, 1912, the business of this, the Fifteenth Annual Meeting of the Society, has been limited to the reception of committee reports and to administrative business. For like reasons the meeting is held three months earlier than usual, so that the present report covers only a nine months period in the activities of the Society.

The Executive Committee records with sorrow the death of Mr. James Christie, a member of that Committee since 1902. which occurred on August 24, 1911. At a special meeting of the Executive Committee, held for that purpose, the following Minute, prepared by the Secretary, was read and adopted by a rising vote:

"In recording the death of their friend and associate James Christie, which occurred scarcely without warning, on August 24, 1911, the members of the Executive Committee desire to give expression jointly to their common sorrow, their deep sense of personal loss, and their grateful appreciation of his long and devoted services to the Society.

"Mr. Christie's connection with the Society began with its organization in 1898 as the American Section of the International Association. His faith in the destiny of the Society and in its immediate opportunity for usefulness was unwavering from the first. As one of the original members of the Committee on Specifications for Iron and Steel, he participated faithfully and ably in the exacting labor of preparing the first series of specifications for presentation to the Society in 1900. Since the incorporation of the Society in 1902, under its present name and charter, he has rendered conspicuous service as a member of the Executive Committee. Throughout this period of nine years, ending only with his death, he attended the meetings of that

Committee with unfailing regularity. He brought to his duties a mind full-stored with the experiences of a long and active life, coupled with a tolerant spirit and a firm faith in human nature. His counsel was valued for its moderation, no less than for its wisdom. He saw things clearly, but always calmly; his mental bent was essentially judicial; his equanimity was that of one who stood on a plane far above that of factional contention; who adhered easily to simple standards of candor, honesty and truth; and who was never known to be betrayed into an intemperate or uncharitable utterance.

"In engineering circles, Mr. Christie was widely known and honored for his professional attainments, and among his townsmen he was esteemed highly for the quality of his citizenship. His friends saw much to love and to admire in the serenity, kindliness and artless simplicity of his nature, and in the essential dignity of his manhood.

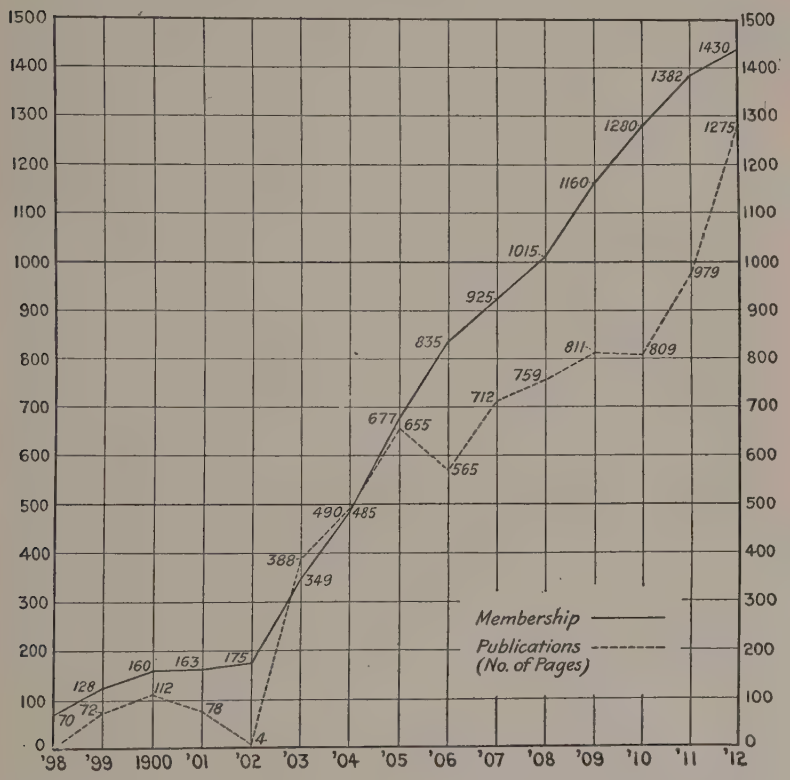
"In giving expression to this tribute of respect and affection for one whom they have known long and well, the members of the Executive Committee desire also to convey their heartfelt sympathy to his widow and to his family."

Membership.—The membership at the last annual meeting was 1,382. Since then 166 applications for membership have been approved. The Society has suffered the loss of 11 members by death:

J. F. Hinckley	February 19, 1911.
J. J. Kern	March 12, 1911.
F. E. Hobbs	April 12, 1911.
James Christie	August 24, 1911.
J. B. Atkinson	September 21, 1911.
C. A. Matcham	September 22, 1911.
E. L. Hancock	October 1, 1911.
U. E. Taubenheim	December 19, 1911.
E. R. Buckley	January 19, 1912.
E. T. Newsome	February 6, 1912.
H. W. Spangler	March 17, 1912.

The number of resignations is 51, and 56 members have been dropped for arrears in dues. The total loss from all causes is 118, leaving a net gain of 48 for the last nine months, and mak-

ing the total membership at present 1,430. This estimate includes 48 members in arrears for dues prior to January 1, 1912, the Executive Committee having decided to extend the time for delinquents to April 1, 1912. The number of members in arrears for dues included in the last annual report was 76, so that the reported net gain of 48 in the membership is in reality 76. This



is equivalent to a gain of 101 for a full year period. Since the effect of the doubling of the dues on August 1, 1910, is now fully revealed, it is highly gratifying to note that it has not only not resulted in a temporary decrease, but that it has been accompanied by a fair increase in membership.

Publications.—The publications since the last annual meeting comprise a Year-book of 385 pages (as compared with

308 pages in the 1910 Year-book); Volume XI of the Proceedings, containing 890 pages (as compared with 671 pages in Volume X); and twelve official circulars of information. The recently issued volume of the Proceedings is about one-fourth larger than any previous volume, and in point of mechanical execution, it is by far the best publication thus far published by the Society. It is worth while, perhaps, to direct attention to the following special features: The numerous photomicrographs in Plates I–IV reproduced by the photo-gelatine process, which is far superior to the half-tone process on account of the absence of dots caused by the screens; Plate V, printed in colors; numerous line-cuts reproduced from drawings prepared in the office of the Secretary. Negotiations are in progress with a view of placing such work, as well as the re-touching of material for half-tones, entirely in the hands of one of the leading experts in that line in this country, so that future publications are expected to show further improvement in these directions. The members of the Society may rest assured that the Executive Committee is keenly alive to the importance of sparing no reasonable expense towards bringing the publications of the Society to the highest plane, not only as to their intrinsic value but also their mechanical execution.

The resolution passed at the last annual meeting which has led to the appointment of a committee, known as Committee E-5 on Rules Governing the Form but not the Substance of Specifications, marks an important step in the direction of the unification and simplification as to form of the standard specifications of the Society. Committee E-5 has prepared a report for presentation at this meeting containing regulations which have already been applied to many of the specifications to be presented to the Society at this time. It is hoped that within the next year or two it will be found possible to reprint all of the present standard specifications in conformity with these regulations. It is perhaps not too much to expect that these regulations will in due time meet with general adoption in outside circles, so that all specifications for materials may become alike in their general form and arrangement, to the great relief of the users of such specifications.

The material for the Index of Volumes I–X of the Proceed-

ings is in an advanced state of preparation, and it is hoped that the financial condition of the Society will admit of its publication during the current year. As previously announced, every member of the Society will receive a cloth-bound copy of this Index without extra charge.

An arrangement has been made with the Council of the International Association by which every Member of the Society will also receive a cloth-bound copy of the English edition of the Proceedings of the approaching International Congress without extra charge. Junior Members will be entitled to a copy of this publication on the payment of the nominal sum of $2.50. The Proceedings of the last Congress were printed in a volume of about one thousand pages. The indications are that the Proceedings of the Sixth Congress will be considerably more voluminous, so that it may be found necessary to issue them in two volumes.

Technical Committees.—The changes in technical committees include the merging of Committee A-10 on Standard Specifications for Staybolt Iron, with Committee A-2 on Standard Specifications for Wrought Iron; and the appointment of the following new committees:

Committee A-10 on Hardness Tests, under the chairmanship of Mr. Bradley Stoughton.

Committee D-11 on Standard Specifications for Rubber Products, under the chairmanship of Mr. Edwin B. Tilt.

Committee E-5 on Rules Governing the Form but not the Substance of Specifications, under the chairmanship of Mr. Edgar Marburg.

The Executive Committee has been made an important amendment of the Regulations Governing Technical Committees by the addition of the following paragraph:

Any recommendation affecting specifications must be transmitted to the Secretary of the Society at least eight weeks in advance of the date of the annual meeting, and copies of these recommendations, in printed form, must be mailed by the Secretary to every member of the Society not less than four weeks before the annual meeting, so that members may come to the meeting prepared to discuss such recommendations, and that members

not intending to be present at the meeting may contribute discussions by letter. The final adoption of new or amended specifications shall be (as at present) subject to the following procedure:

1. Approval at the annual meeting by two-thirds vote of those voting.
2. Approval by letter ballot of the Society by two-thirds vote of those voting.

As is seen from the program for this meeting, the technical committees have been active in a more than ordinary degree. Committee A-1 on Standard Specifications for Steel, has prepared two proposed revised specifications and eleven proposed new specifications; Committee A-2 on Standard Specifications for Wrought Iron, has prepared one proposed revised and three proposed new specifications; and Committee B-1 on Standard Specifications for Copper Wire, has prepared two proposed new specifications. The organization and effectiveness of some of the general committees has been greatly increased through the creation of numerous sub-committees, whose relations to the parent committee are similar to the relations of the latter to the Society.

The work of some of these committees has been given greater breadth through their cooperation with committees of representatives of societies in related fields, as, for example, the American Electric Railway Engineering Association and the American Railway Master Mechanics Association. The Bureau of Construction and Repair, U. S. N., and the Bureau of Steam Engineering, U. S. N., have acquired four perpetual memberships in the Society, and these bureaus are now directly represented on many of the technical committees.

Finances.—The marked improvement of the financial condition of the Society incident to the increase of dues is reflected in the subjoined report of the Treasurer. The cash balance on March 15, 1912, was $6725.57, with no outstanding liabilities except $801.85 owing to the International Association for dues collected since January 1, 1912. The proceeds from the sale of publications during the past period of nine months amounts to $982.82, which represents a marked decrease in comparison with the receipt from this source for a year, ($2539.60) recorded in the last annual report of the Executive Committee. This decrease is due largely to the circumstance

that the proceeds for the three-months period immediately following the appearance of the Proceedings were included in the latter report, but do not figure in the present one.

The prospective receipts till December 31, 1912, from dues and the sale of publications may be roughly estimated at $6000. In the meantime it is expected to issue the 1912 Year-book, the Proceedings of the Fifteenth Annual Meeting, and, in addition to the running expenses of the Society, a payment of $2500 to the International Association will have to be made on July 1, 1912, to be followed on February 1, 1913, by the payment of a like sum, in conformity with the agreement previously referred to in this report, by which every member of the Society will receive a copy of the Proceedings of the International Congress.

The time is near at hand when the finances of the Society will admit of the adoption of a more liberal policy than in the past with respect to the technical committees, and in various other directions, which will accrue directly to the advantage of the membership at large.

ANNUAL REPORT OF THE TREASURER.

From June 15, 1911, to March 15, 1912.

RECEIPTS.

Membership dues		$11 806.59	
Sales of publications		982.82	
Orders for binding		134.00	
Authors' reprints		158.76	
Sales of right to reprint specifications for one year		250.00	
Sales of Dudley Memorial Volume		100.37	
Interest on deposits		110.22	
Miscellaneous receipts		30.20	
Sixth International Congress:			
Refunded expenses	$83.67		
Cancellation of temporary loan to Organizing Committee	1 500.00		
Subscriptions payable to the Organizing Committee	130.00		
		1 713.67	
International Association dues and sales of publications,		1 006.87	
Total receipts		$16 293.50	
Cash balance, June 15, 1911		6 792.05	
			$23 085.55

DISBURSEMENTS.

Publications:			
Printing, engraving, binding, etc.	$8 430.98		
Clerical services	907.48		
		$9 338.46	
Salaries (including Secretary's salary at the rate of $2,500 per annum)		3 435.83	
Accountant's audits		80.00	
Expenses, Secretary's office:			
Postage and expressage	$266.32		
Miscellaneous expenses	280.39		
		546.71	
Rent and insurance, storage room		101.60	
Stenographer, Fourteenth Annual Meeting		194.50	
Expenses, Fourteenth Annual Meeting		235.93	
Expenses, Technical Committees		300.75	
Dudley Memorial Volume		106.18	
Miscellaneous disbursements		11.61	
Sixth International Congress:			
Miscellaneous expenses	$54.72		
Loans to Organizing Committee	1 500.00		
Subscriptions	130.00		
		1 684.72	
Remitted to International Association for dues and sales of publications		323.69	
Total disbursements		$16 359.98	
Cash balance, March 15, 1912		6 725.57	
			$23 085.55

ANALYSIS OF DISBURSEMENTS FOR ACCOUNT OF PUBLICATIONS.

	Clerical services.	Printing and mailing.	Total.
Year-book and Membership Pamphlet	$147.66	$1 762.30	$1 909.96
Proceedings	691.07	5 531.21	5 222.28
Index, Vols. I–X	62.25	.....	62.25
Circulars to Members	1.50	299.13	300.63
Preprints	.....	324.95	324.95
Reprints	.....	317.50	317.50
Miscellaneous	5.00	195.89	200.89
	$907.48	$8 430.98	$9 338.46

COMMITTEE FUNDS.

RECEIPTS.

Interest on deposit	$2.59	
Cash balance, June 15, 1911	242.42	
		$245.01

DISBURSEMENTS.

Committee D-1	$51.08	
Cash balance, March 15, 1912	193.93	
		$245.01

The last report of semi-annual audit of the books and accounts of the Society, presented on January 4, 1912, is as follows:

JOHN HEINS & CO.

PUBLIC ACCOUNTANTS & AUDITORS.

Philadelphia, January 4, 1912.

Dear Sirs:—We respectfully report that we have made an audit and examination of the books and accounts of your Society for the six months ended December 31, 1911, and report them to be correct, and that the accounts are in the same excellent condition as at our last examination.

We submit balance sheet as of December 31, 1911, as also a statement of operations for the twelve months then ended, schedules of Accounts Receivable and Payable, etc.

Yours respectfully,

(Signed) JOHN HEINS & CO.

Proposed Amendment of the By-Laws.—As previously announced, the Executive Committee has decided to recommend certain amendments of the by-laws designed to provide, first, for a new class of Honorary Members; second, for rotation in office and in membership of the Executive Committee; and third, for minor changes in the composition of the Executive Committee. The by-laws affected and the proposed amendments are as follows:

ARTICLE I. MEMBERS

Strike out:

SECTION 1. The Society shall consist of Members and Junior Members.

Substitute:

SECTION 1. The Society shall consist of Junior Members, Members, and Honorary Members.

Add the following new section:

SEC. 4. An Honorary Member shall be a person of widely recognized eminence in some part of the field which the Society aims to cover as defined in Paragraph 2 of the Charter. The number of Honorary Members shall not exceed ten. A nominee for honorary membership shall be proposed by at least ten members and shall be elected only by unanimous vote of the Executive Committee.

Number the present Section 4, Section 5.

ARTICLE II. OFFICERS AND THEIR ELECTION.

Strike out:

SECTION 1. The officers shall be a President, Vice-President, Secretary and Treasurer.

SEC. 2. The offices of Secretary and Treasurer shall be held by the same person.

SEC. 3. These officers shall be elected by letter ballot, at the Annual Meeting, and shall hold office for two years.

SEC. 4. The Executive Committee shall consist, of these officers and also the last Past President and seven members, four being elected by letter ballot at each Annual Meeting in the odd years and three at each Annual Meeting in the even years. Four members of the Executive Committee shall constitute a quorum.

SEC. 5. The President shall be, *ex officio*, the nominee for American Member of the Council of the International Association.

Substitute:

SECTION 1. The officers shall be a President, a First Vice-President, a Second Vice-President, and a Secretary-Treasurer.

SEC. 2. These officers shall be elected by letter ballot at the Annual Meetings. The President shall hold office for one year. The two Vice-Presidents and the Secretary-Treasurer shall hold office for two years. The term of office of the First Vice-President and of the Secretary-Treasurer shall expire in the even years and that of the Second Vice-President in the odd years.

SEC. 3. The Executive Committee shall consist of these officers and eight members, four being elected by letter ballot at each Annual Meeting. Four members of the Executive Committee shall constitute a quorum.

SEC. 4. The President, the two Vice-Presidents and the members of the Executive Committee shall be ineligible for re-election to the same office

until at least one full term shall have elapsed after the end of their respective terms.

SEC. 5. The officers and members of the Executive Committee to hold office under these by-laws shall be as follows:

To hold office for one year:—the President elected this year (1912), the Second Vice President, to be appointed by the Executive Committee, and the following members of the present Executive Committee: W. A. Bostwick, Robert W. Hunt, Richard Moldenke and William R. Webster.

To hold office for two years:—the First Vice-President elected this year (1912), the Secretary-Treasurer elected this year (1912), the three members of the Executive Committee elected this year (1912), and a fourth member to be appointed by the Executive Committee.

ARTICLE V. DUES.

Strike out:

SECTION 1. The fiscal year shall commence on the first of January. The annual dues shall be $10.00 for Members and $5.00 for Junior Members, payable in advance.

Substitute:

SECTION 1. The fiscal year shall commence on the first of January. The annual dues shall be $10.00 for Members and $5.00 for Junior Members payable in advance. Honorary Members shall not be subject to dues.

International Association for Testing Materials.—The American membership in the International Association has shown a gratifying rate of growth since the last annual meeting. The total American membership at that time was 473 and it is now 594, a number substantially greater than the representation in that organization from any other country. Every member of the American Society is in virtue of such membership eligible for admission to the International Association. The annual dues are $2.00, the fiscal year beginning on January 1. Application blanks may be obtained on application from the Secretary of the American Society. It is hoped that the American membership will be greatly increased prior to the Sixth Congress of the International Association for Testing Materials, to be convened in New York on September 3–7, 1912. The preparatory arrangements for that Congress are well advanced and the indications are that the occasion will be highly creditable to that organiza-

tion. More detailed announcements have been issued from time to time by the Organizing Committee, so that it is hardly necessary that they should be stated here.

Respectfully submitted on behalf of the Executive Committee,

HENRY M. HOWE,
President.

EDGAR MARBURG,
Secretary-Treasurer.

APPENDIX.

ABSTRACT OF THE MINUTES OF THE EXECUTIVE COMMITTEE.

REGULAR MEETING, June 28, 1911.—Hotel Traymore, Atlantic City, N. J. Present: Mr. Henry M. Howe, President; Mr. Robert W. Lesley, Vice-President; Mr. James Christie and Mr. R. W. Hunt, Members of the Executive Committee; and Mr. Edgar Marburg, Secretary-Treasurer; and by invitation, Mr. A. A. Stevenson and Mr. Albert Ladd Colby.

The Secretary reported that favorable action had been taken on 47 new applications for membership, that two members had resigned, and that two members had been dropped, making the total membership on June 15, 1911, 1382.

The following proposals from Committee A-1 on Standard Specifications for Steel, were presented:

I. That the Executive Committee consider the advisability of merging with Committee A-1 all other existing committees whose work relates partly or wholly to specifications for steel or steel products, with the understanding,

(*a*) That the number of sub-committees of Committee A-1 would be suitably increased to provide for the added subjects, and that the members of the existing committees in question would be appointed to membership on the corresponding sub-committees.

(*b*) That the proposed arrangement is not intended to affect the independent continuation of existing committees, in so far as work not relating to specifications is concerned.

II. That the Executive Committee authorize the Secretary to print in the Year-book certain important specifications of other organizations, both to facilitate the work of the committees on specifications, and for the information of the membership of the Society at large.

It was agreed to authorize Mr. Albert Ladd Colby to proceed with the work of Sub-Committee XI (of Committee A-1) on Standard Specifications for Automobile Steels, but to defer action on the general question involved under Proposal I.

Favorable action was taken with respect to Proposal II.

The Secretary recommended the presentation of the following recommendations on behalf of the Executive Committee at one of the sessions of the annual meeting:

1. That the next annual meeting of the American Society to be held in June, 1912, shall be limited to (*a*) the reports of standing technical committees, and (*b*) administrative business.

2. That the Executive Committee be authorized to enter upon a financial arrangement with the International Association whereby (*a*) every Member of the American Society shall receive without extra charge above the regular dues in that Society, the complete Proceedings of the Sixth Congress in the English language; and (*b*) every Junior Member of the Society shall be entitled to a copy of these Proceedings upon the additional optional payment of $2.50.

3. That if the sense of the meeting shall be favorable to Proposals 1 and 2, these proposals shall be subject finally to a letter ballot of the Society.

On motion these recommendations were approved.

The Secretary announced the completion of the organization of Committee A-2 on Standard Specifications for Wrought Iron, and progress in the organizing of Committee C-6 on Standard Tests and Specifications for Drain Tile, and Committee E-3 on the Definition of the Term "Modulus of Elasticity."

On motion the Secretary was instructed to differentiate in some distinctive way the names of producers and non-producers in the personnel of the standing technical committees in the Year-book.

The Secretary was further authorized to proceed with the preparation of a general index of Volumes I–X inclusive.

SPECIAL MEETING, June 30, 1911.—Hotel Traymore, Atlantic City, N. J. Present: Mr. Henry M. Howe, President; Mr. Robert W. Lesley, Vice-President; Mr. James Christie and Mr. Richard Moldenke, Members of the Executive Committee; and Mr. Edgar Marburg, Secretary-Treasurer.

The President announced the general object of the meeting, namely the consideration of the appointment to the secretaryship of the Organizing Committee of the Sixth Congress of the International Association for Testing Materials.

After the discussion of this subject in many phases it was decided to recommend Mr. H. F. J. Porter to the Organizing Committee for the office in question.

The Chair presented a proposal from Mr. Bradley Stoughton that the Executive Committee should take under advisement the appointment of a Committee on Hardness Tests. After some discussion it was decided that, with the approval of Committee E-1 on Standard Methods of Testing, the subject of hardness tests should be entrusted to a sub-committee of that Committee, after the enlargement of that Committee by the addition of members especially well qualified to deal with the subject of hardness tests.

SPECIAL MEETING, August 30, 1911.—Engineers' Club, New York City. This meeting was held for the purpose of taking appropriate action on the death of Mr. James Christie, a member of the Executive Committee, which occurred on August 24, 1911. The Minute adopted at this meeting by a rising vote appears in full in the body of this report of the Executive Committee.

REGULAR MEETING, October 14, 1911.—United Engineering Building, New York, N. Y. Present: Mr. Henry M. Howe, President; Mr. Robert W. Lesley, Vice-President; Mr. W. A. Bostwick, Mr. Richard Moldenke and Mr. W. R. Webster, Members of the Executive Committee; and Mr. Edgar Marburg, Secretary-Treasurer.

The Secretary reported that favorable action had been taken on 52 new applications for membership, that 56 members had been dropped for non-payment of dues, and that there had been a loss of 4 members by death, making the total membership on October 1, 1911, 1374.

The Treasurer presented a report from John Heins & Co., Public Accountants and Auditors, dated July 10, 1911, as follows:

"We respectfully report that we have made an audit and examination of the books and accounts of your Society for the six months ended June 30, 1911, and report them to be correct, and that the accounts are in the same excellent condition as at our last examination. We suggested to your bookkeeper the opening of a cash payment book which he is to install at his earliest convenience."

The Secretary presented a report from the Committee of Tellers consisting of Mr. H. H. Quimby and Mr. W. P. Taylor, on a recent letter ballot of the Society, embodying the following results:

	For.	Against.	Not voting.
Amendment of Art. V of the By-Laws	117	2	11
Adoption of Resolution (*b*)[1]	119	1	10
Standard Specifications for Heat-treated Carbon-steel Axles, Shafts, and Similar Parts	87	9	34
Standard Specifications for Steel Reinforcement Bars	87	13	30
Practice Recommended for Annealing Miscellaneous Rolled and Forged Carbon-Steel Objects	84	14	32
Standard Magnetic Tests of Iron and Steel	82	0	48
Amendments of the Standard Specifications for Hard-drawn Copper Wire	85	0	45
Standard Specifications for Copper-wire Bars, Cakes, Slabs, Billets, Ingots, and Ingot Bars	82	1	47
Standard Specifications for Spelter	82	1	47

[1] "*Resolved*, That the Executive Committee be authorized to effect a financial arrangement with the Council of the International Association by which every Member of the American Society will receive, without extra charge, a copy of the English edition of the Proceedings of the Sixth Congress, and by which every Junior Member of the American Society will receive a copy of these Proceedings on the extra payment of $2.50."

	For.	Against.	Not voting
Standard Specifications for Manganese-bronze Ingots	86	2	42
Provisional Method for the Determination of Soluble Bitumen	78	1	51
Provisional Method for the Determination of the Penetration of Bitumen	76	1	53
Provisional Method for the Determination of the Loss on Heating of Oil and Asphaltic Compounds	74	3	53
Provisional Method of Sizing and Separating the Aggregate in Asphalt Paving Mixtures	75	1	54
Standards Methods for Transverse Tests	92	0	38

Total number of ballots cast, 130.

Mr. A. A. Stevenson was nominated and elected to the vacancy on the Executive Committee caused by the death of Mr. James Christie.

The Secretary reported the appointment by the President of the following representatives of the Society at the Third National Conservation Congress: A. L. Johnson, C. D. Purdon, J. L. Van Ornum, Hermann Von Schrenk, and J. A. L. Waddell.

The Secretary reported that 260 copies of the Dudley Memorial Volume remained on hand. The following proposals for the disposal of these volumes were approved:

1. That the requirements of Mrs. Dudley shall first be met.
2. That an announcement shall be inserted in the next Circular to Members requesting those who may desire copies of this volume to file their orders for the same prior to a specified date and that after that date the volume will be withdrawn from sale.
3. That 25 copies of the volume shall be reserved by the Society to meet special requirements in the future.
4. That the Secretary be allowed six copies of the volume for his personal use.
5. That the remaining copies of the volume shall be donated to libraries, especially those connected with institutions of learning and important public libraries.

On motion the action at the meeting of the Executive Committee held on June 30, relative to the appointment of a sub-committee on Hardness Tests of the general committee on Methods of Testing, was reconsidered and it was decided to appoint an independent committee on the subject of Hardness Tests.

It was decided to authorize the appointment of a Committee to Formulate Rules Governing the Form but not the Substance of Specifications, and

that this Committee shall consist of the Secretary and one representative to be appointed by each technical committee concerned with the standardization of specifications or methods.

The Secretary presented letters from Mr. P. E. Carhart and Mr. A. A Stevenson recommending the adoption of regulations calculated to insure a formal censorship of all papers to be presented at the annual meetings, and, if possible, a plan by which all papers will be in type before the meetings.

The following provisional action bearing on these recommendations was taken:

(*a*) Authorization to enlarge the Committee on Publications so as to include a thoroughly representative personnel irrespective of membership on the Executive Committee, and

(*b*) The amendment of the Regulations Governing Technical Committees by the addition of the following paragraph:

Any recommendations affecting specifications must be transmitted to the Secretary of the Society at least eight weeks in advance of the date of the annual meeting, and copies of these recommendations, in printed form, must be mailed by the Secretary to every member of the Society not less than four weeks before the annual meeting so that members may come to the meeting prepared to discuss such recommendations, and that members not intending to be present at the meeting may contribute discussions by letter. The final adoption of new or amended specifications shall be (as at present) subject to the following procedure:

1. Approval at the annual meeting by two-thirds vote of those voting.
2. Approval by letter ballot of the Society by two-thirds vote of those voting.

The Secretary submitted a copy of Circular No. 60 to Members, announcing that the Executive Committee was withholding the letter ballot on the following Resolution pending the full consideration of the question referred to at the next meeting of that Committee, in order that the same may in due course be presented to the members of the Society in such a manner as to enable them to vote with full information. The Resolution in question, adopted at the last annual meeting, is as follows:

(*a*). "That in view of the Sixth Congress of the International Association for Testing Materials, which will be held in this country in September, 1912, the next annual meeting be held in June, 1912, and that it be limited to the annual reports of the standing technical committees and administrative business."

The Secretary was instructed to take a letter ballot of the Society in accordance with the provisions embodied in the following Resolutions:

"*Whereas*, it is the judgment of the Executive Committee that the holding of the next annual meeting in June, 1912, as recommended by the Society at the last annual meeting, may affect the success of and attendance at the forthcoming Congress of the International Association for Testing Materials in September, 1912, of which the American Society is host, and

"*Whereas*, it is deemed advisable that the annual meeting of the Society should be held prior to the Congress for the consideration of reports of the standing technical committees and administrative business, and that the meeting should be held at an earlier date than June, 1912.

"*Resolved*, that the Resolution adopted at the last annual meeting of the Society, namely,

(*a*). 'That in view of the Sixth Congress of the International Association for Testing Materials, which will be held in this country in September, 1912, the next annual meeting be held in June, 1912, and that it be limited to the annual reports of the standing technical committees and administrative business.'

be amended by striking out the words 'June, 1912' and substituting the words 'prior to April, 1912' so that the Resolution as amended shall read:

'That in view of the Sixth Congress of the International Association for Testing Materials, which will be held in this country in September, 1912, the next annual meeting be held prior to April 1, 1912, and that it be limited to the annual reports of the standing technical committees and administrative business.'

and that the Resolution in its amended form shall be sent out to letter ballot to the members of the Society to vote,

"First, To rescind and repeal the action of the Society in adopting Resolution (*a*) at its meeting in June, 1911, and to substitute therefor the amended resolution, and to submit the same to letter ballot, and

"Second, To vote 'Yes' or 'No' on the resolution as amended by the Executive Committee and authorized as above to be sent out to letter ballot."

The Secretary reported the recommendation from Mr. J. Allen Colby, Chairman of Committee A-2 on Standard Specifications for Wrought Iron, approved by the acting Chairman of Committee A-10 on Standard Specifications for Staybolt Iron, that these two committees be merged.

On motion this recommendation was approved.

The Secretary announced the receipt of an invitation to the American Society for Testing Materials to join the Eighth International Congress of Applied Chemistry and to take part in its proceedings. The Secretary was instructed to convey to the officers and members of the Executive Committee of the Eighth International Congress of Applied Chemistry the appreciative acknowledgment and acceptance of this invitation on the part of the Executive Committee.

REGULAR MEETING, January 6, 1912.—Engineers' Club, Philadelphia. Present: Mr. Henry M. Howe, President; Mr. Robert W. Lesley, Vice-President; Mr. Richard Moldenke, Mr. A. A. Stevenson and Mr. W. R. Webster, Members of the Executive Committee; and Mr. Edgar Marburg, Secretary-Treasurer.

The Secretary reported that favorable action had been taken on 35 applications for membership, that 14 members had resigned, and that there had been a loss of 2 members by death, making the total membership on December 30, 1911, 1390.

The Treasurer presented a report from John Heins & Co., Public Accountants and Auditors, dated January 4, 1912, as follows:

"We respectfully report that we have made an audit and examination of the books and accounts of your Society for the six months ended December 31, 1911, and report them to be correct, and that the accounts are in the same excellent condition as at our last examination."

The Secretary presented the following report of the tellers, Mr. H. H. Quimby and Mr. W. P. Taylor, on the recent letter ballot:

1. On rescinding and repealing the action of the Society in adopting Resolution (*a*) at its meeting in June, 1911, and substituting therefor the amended resolution proposed in Circular No. 64, and submitting the same to letter ballot.

For, 252. Against, 3. Not voting, 5.

2. On the adoption of the amended resolution contained in Circular No. 64.

For, 253. Against, 4. Not voting, 3.

Total number of legal ballots cast, 260.

The Secretary presented a recommendation from Committee E-5 on Rules Governing the Form but not the Substance of Specifications, that it be made responsible for the Regulations Governing Technical Committees. It was accordingly decided to authorize this arrangement with the understanding that any proposed changes in these Regulations originating with Committee E-5 shall be subject to approval by the Executive Committee. Also, that the Executive Committee will make no changes in these Regulations without first referring the same to Committee E-5.

The Secretary presented letters from Mr. John R. Freeman, Mr. W. C. Geer, Mr. E. B. Tilt and Mr. C. D. Young, relative to the creation of a Committee on Standard Specifications for Rubber Products. The creation of such a committee was authorized and the appointments on the same were left with power to the President and Secretary-Treasurer.

The Secretary reported the appointment by the President of the following representatives at a conference to be held in San Francisco on January 15, 1912, to consider a tentative plan for an Engineering Congress in that city in connection with the Exposition to be held in 1915: Mr. Loren E. Hunt, Mr. C. F. Wieland and Mr. C. B. Wing.

The Secretary presented the following proposed amendments of the by-laws with a view of creating a class of Honorary Members:

ARTICLE I. MEMBERS.

That Section 1, which now reads "The Society shall consist of Members and Junior Members," be amended to the following form: "The Society shall consist of Junior Members, Members, and Honorary Members."

The addition of the following Section 4:

"An Honorary Member shall be a person of widely recognized eminence in some part of the field which the Society aims to cover as defined in Paragraph 2 of the Charter. The number of Honorary Members shall not exceed ten. A nominee for honorary membership shall be proposed by at least ten members and shall be elected only by unanimous vote of the Executive Committee, except that the last Past President, if proposed for honorary membership, shall not be required to vote either for or against his own admission."

ARTICLE V. DUES.

That Section 1, which now reads "The fiscal year shall commence on the first of January. The annual dues shall be $10.00 for Members and $5.00 for Junior Members, payable in advance," be amended by adding the statement, "Honorary Members shall not be subject to dues."

On motion these proposed amendments were adopted, subject to the procedure for adoption by the Society prescribed by the by-laws.

On motion it was decided to hold the next annual meeting of the Society in New York on Thursday and Friday, March 28 and 29, and to extend the meeting to Saturday, March 30, if necessary.

The Secretary announced the prospective expiration of the terms of offices of the President, Vice-President, Secretary-Treasurer, Mr. A. A. Stevenson, who was appointed to fill the unexpired term of Mr. James Christie, and two additional appointments on the Executive Committee authorized by an amendment of the by-laws.

The Secretary was charged to draw up proposed amendments of the by-laws with a view of definitely limiting the term of office of certain officers and of the members of the Executive Committee, with the understanding that the adoption of these proposed amendments shall be determined by letter ballot of the Executive Committee.

The Secretary reported that the chairmen of certain standing technical committees considered it doubtful, or impossible, to comply with the regulations governing reports on specifications to be presented at the annual meetings in the form adopted by the Executive Committee, as announced in Circular No. 65, in view of the fact that the 1912 meeting is to be held in March.

On motion the Secretary was authorized to advise the chairmen of all technical committees that, while it was desirable that these regulations should be adhered to if possible, it is not the intention that they should be enforced literally before the 1913 meeting.

The Secretary presented a letter under date of December 22, 1911, from the International Association for Testing Materials, in which the Secretary of that Association expressed his full approval of the proposed financial arrangement for the publication and distribution of the Congress Proceedings among the members of the American Society, and stated his intention to recommend the adoption of this proposal at the next meeting of the Council.

The Secretary was instructed to advise the chairmen of all technical committees concerned with the preparation of standard specifications for material that their committees were authorized to propose standards of form and size wherever such standardization appeared desirable.

The following proposal made by Mr. W. R. Webster was approved, subject to the approval of the Organizing Committee of the Sixth Congress of the International Association:

That the standard specifications for steel be printed in English, French, German and Spanish in the form of a single volume for free distribution among the members of the International Railway Congress and the participants at the Sixth Congress of the International Association, provided the requisite sum for that purpose (roughly estimated at $4000) is raised over and above the sum of $20,000 for the general purposes of the Congress.

Society Emblem

The Society Emblem, adopted in 1910, is shown above in full size. The letters are in gold on a black enameled background. The emblem mounted on a disk for use as a fob charm is shown below in full size.

The Executive Committee has made an exclusive arrangement for the manufacture and sale of the emblem to members of the Society with the firm named below, with whom orders may be placed direct at the following prices:

Price List.

I. Gold badge, with pin and safety catch	$3 50
(*a*) With initials and year of membership engraved on back without extra charge.	
(*b*) With full name engraved on back and year of membership at an extra charge of	25
II. Gold fob charm with emblem mounted on disk	9 50
(*a*) With initials and year of membership engraved on back without extra charge.	
(*b*) With full name and year of membership engraved on back without extra charge.	
III. Gold bail and silk ribbon for watch fob, complete	4 00

Note.—Orders under I or II should include explicit reference to directions (*a*) or (*b*). Orders should be directed to J. E. Caldwell and Company, 902 Chestnut Street, Philadelphia, Pa.

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OF

PROCEEDINGS.

NOTE.—The Society, from its organization in 1898 till its incorporation under its present name in 1902, was designated the American Section of the International Association for Testing Materials. During this period twenty-eight (28) Bulletins were issued, which, collectively, constitute Volume I. of the Proceedings. In 1902 it was decided to publish the Proceedings in the form of annual volumes. Volume II. is the first volume of this new series.

VOLUME I.

Bulletin No. 1. Minutes of the Organization Meeting, June 16, 1898. Minutes of the Executive Committee, June 25, 1898, to February 22, 1899. Minutes of First Annual Meeting, August 27, 1898. April 1899. Pp. 1–8.

Bulletin No. 2. Provisional Program for the Second Annual Meeting. July, 1899. Pp. 9–12.

Bulletin No. 3. Officers of the American Section. Program of the Second Annual Meeting. August, 1899. Pp. 13–16.

Bulletin No. 4. The work of the International Association for Testing Materials. Annual Address by the Chairman, Professor Mansfield Merriman. September, 1899. Pp. 17–26.

Bulletin No. 5. Preliminary Report on the Present State of Knowledge Concerning Impact Tests, by Professors W. Kendrick Hatt and Edgar Marburg. October, 1899. Pp. 27–52.

Bulletin No. 6. Report of Second Annual Meeting, August 15–16, 1899. Minutes of the Executive Committee to August 16, 1899. November 1899. Pp. 53–72.

Bulletin No. 7. Minutes of the Executive Committee to January 6, 1900. Miscellaneous Announcements. January, 1900. Pp. 73–80.

Bulletin No. 8. Proposed Standard Specifications for Structural Steel for Bridges and Ships. May, 1900. Pp. 81–86.

Bulletin No. 9. Proposed Standard Specifications for Structural Steel for Buildings. May, 1900. Pp. 87–92.

Bulletin No. 10. Proposed Standard Specifications for Open-hearth Boiler Plate and Rivet Steel. May, 1900. Pp. 93–100.

Bulletin No. 11. Proposed Standard Specifications for Steel Rails. May 1900. Pp. 101-106.

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